TRANSACTIONS

—OF THE—

AMERICAN

FISH CULTURAL ASSOCIATION.

SEVENTH ANNUAL MEETING,

February 27th and 28th, 1878.

Held at the Directors' Rooms of the Fulton Market Fish Mongers' Association.

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New York City.

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SEVENTH ANNUAL MEETING

—OF—

THE FISH CULTURAL ASSOCIATION.

WEDNESDAY, February 27, 1878.

THE meeting having been called to order by the President, ROBERT B. ROOSEVELT, Esq., the minutes of the former meeting were then read by the Secretary, B. PHILLIPS, Esq., and the same were approved.

The various sections were then called on the report by the President. These sections and the members selected to treat on the subjects were as follows:

SECTION 1. Methods in Fish Culture and Apparatuses, conducted by SETH GREEN, of Rochester, N. Y.: B. B. PORTER, of Colorado, and SAMUEL WILMOT, of Ottawa, Canada.

SECTION 2. Fishing Laws and Fishways, under charge of CHARLES B. EVARTS, of Windsor, Vt.: LIVINGSTONE STONE, of Charleston, N. H., and T. P. FERGUSON, of Annapolis, Md.

SECTION 3. On Natural History and Aquaria under the control of Professor JAMES W. MILNER, of Washington, D. C.: FREDERICK MATHER, of New York, and CHARLES HALLOCK.

SECTION 4. On Fisheries, under care of EUGENE G. BLACKFORD, BARNET PHILLIPS and M. E. EDWARDS, of Western Vermont.

These having been formed, a committee to prepare an

obituary on B. F. Bowles, the Secretary read a memorial on the late B. F. Bowles, written by Mr. LIVINGSTONE STONE.

In the absence of R. B. PORTER, Esq., then in California, the following paper was read by the Secretary:

Having been called upon at our last annual meeting to report on Methods of Fish Culture, I will give you my experience and some experiments made, although doubtless the facts may be known to many other practical fish culturists.

I shall confine my remarks to methods of trout-culture, or of the salmon family, leaving the methods of culture of other fish to Messrs. Green and Wilmot, who are more conversant therewith. Being so far away from my base, without notes or memoranda, I shall have to depend entirely upon memory.

The method of raising brook-trout at the present day only varies in appliances from the date of its commencement in this country.

Brook-trout culture is really the mother of fish-culture, whereby our rivers, lakes, ponds, and creeks are already teeming with countless thousands of fish in many localities from the Atlantic to the Pacific.

The salmon family of our country are now being sent to all parts of the world, and yet fish-culture is only in its infancy. At the first regular meeting of this Association at Albany, N. Y., almost every member was interested in the culture of trout or salmon; but now "The Angler's Pride" is hardly thought of, though it is the most difficult fish to raise to maturity of all our food-fishes; consequently it is likely, I think, to remain a luxury, and will always command a good price in market.

In raising trout one must have the natural advantages: 1st. A never-failing spring with a good flow of water (the larger the better). 2d. The water must be of uniform tem-

perature during the whole year. 3d. There must be a good fall. 4th. The stream must not be liable to be washed out by floods during the severest storms. The old method of hatching the spawn on gravel is nearly obsolete. Wire trays, with the wires crossing each other at right angles one-tenth of an inch apart one way and half an inch apart the other, are probably the best for hatching trout or salmon-spawn upon, allowing the fish to fall through as soon as hatched.

There are many ingenious devices for hatching, but if you have your eggs so that you can pick them over readily and keep them clean and exclude the light, it is the easiest part of fish-culture, providing your eggs are well impregnated. The watering-pot will keep the sediment off, and a liberal use of salt will prevent fungus from generating. After the eggs are hatched it is best to remove them to another trough, or rearing-box, where you have spread a half inch or more of fresh earth, and they will generally remain healthy until the sac is absorbed. If the season is as far advanced as the first of April, in the latitude of New York City, at the time the fish begin to feed, it is just as well to turn them out, providing you have a proper place to put them, and instead of ponds, they do as well or better in a small running stream of spring-water, with a pond at the lower end of the stream, where you can place a screen if you do not wish them to descend.

Another method of raising trout was tried with success, by arranging the ponds in the fall, and selecting pairs of ripe trout at different times, for say ten days, and placing them in the pond where they would spawn. As soon as the first pairs had spawned they were removed and others put in, until there were enough eggs in the pond to produce as many fish as were necessary to stock the pond or series of ponds,

with. Then by covering with boards the sun-light was mostly excluded, and they were left to hatch themselves. The fish hatched well and did well, and by giving them free use of three successive ponds, they sorted themselves as perfectly as could be done by hand. There was a fall of eighteen inches between the ponds, so that when they once went down they could not return.

The plan was also tried of letting the fish have a chance to go on the spawning-beds themselves, and then turning them off when they had got through, but this did not yield so many fish as the method last stated. Another method was tried by taking the eggs by what is called the Russian method, or dry impregnation, and placing them immediately in the ponds, and with a turkey's wing making the nest and covering the eggs in the same manner. This plan was more successful than letting the fish into the pond to spawn, and turning them out when they got through. A method of raising the small-fry was tried and found to work well; that was by taking the fish out of the trough or boxes as soon as they began to feed, and placing them in a car or box that had previously been fastened in the race or pond where there was a good current of water. At the upper end of this car was a small screen, and at the lower end another screen three times as large. This worked better than one that was tried with the whole bottom made of wire-screen. The fish did as well or better in this car than in the hatching-house. The cover was made partially of boards, the rest of wire-screen. When the fish had grown to an inch or more in length they were removed to the ponds or streams where they were to remain for the summer. This plan would work and give good satisfaction with salmon-trout, land-locked salmon, and the *Selmo Salar*, and especially with the California salmon.

In trying these different methods more or less trout would die; but having always kept a hatching-house record, I can give you the benefit of my experience in regard to the percentage of trout generally, raised with good care to six months old, one year old, and of trout brought to maturity from the time of taking the spawn—calling the age of maturity when the fish are old enough to spawn.

We will say that you take from good, healthy fish one hundred thousand eggs. With a good, fair impregnation you will be likely to have from 80 to 85 per cent. impregnated (though you may take ten or twenty thousand, and perhaps impregnate from 95 to 99 per cent). Out of these impregnated eggs you will find about five per cent. that have not strength enough to burst the shell of the egg, or die in getting out of the shell. This leaves you from 75 to 80 per cent. hatched. Before the sac is absorbed you will pick out about five per cent. more of dead fish from blue swelling of the sac and various other causes. By the time the fish have been feeding six weeks or two months you will have picked out twenty per cent. more of them from disease and cannibalism. By this time they are ready to turn out, though if you keep them in the hatching-house a month longer you will not be likely to lose many more. Now you have fifty per cent. left. After you have turned them out, and the fish are four months old, from 10 to 15 per cent. more will have died from starvation, cannibalism, disease, snakes, frogs, and birds. At six months old the fish have dwindled down to about 30 per cent. of your original hundred thousand eggs. The next six months, if you have them well sorted, you will not lose more than from 3 to 5 per cent. Therefore, at one year from the time the eggs were taken, 25 per cent. of the products are left. At maturity from 15 to 20

per cent. are all you will have left. Keep them another year, and you will have from five to ten thousand fish out of one hundred thousand eggs. There is quite a difference in these figures and the figures arrived at on the same subject ten years ago, and yet trout-culture is a success. No one has yet, to my knowledge, raised trout exclusively for the table. That it can and will be done with profit is only a question of time. The demand for eggs and small-fry, as well as yearlings, is so much above the supply that no one has tried to do it—exclusively the raising of fish for the table. When capital and skill combine, then we shall hear of the great success of trout culture.

The method of raising trout in a single pond succeed only to a limited extent, yet, by frequent stocking, can be made a source of good sport and furnish many a fine mess for the table.

The methods of raising other species of the salmon family are identical with that of the *Salmo Fontinalis*, but they are more hardy, not subject to so many diseases, and only kept for a short time before being planted in public or private waters, where they take care of themselves.

The above experiments were made at the Crystal Spring Fish Farm, Oakland, Bergen County, N. J., during the last five years by your fellow-member,

B. B. PORTER.

SAN FRANCISCO, CAL., February 15, 1878.

Mr. SETH GREEN: Mr. Porter's conclusions agree pretty well with mine. I will give my ideas as to the way streams should be stocked. When we hatch fish we place them in the rivulets of some main stream which we wish to stock. As soon as the fish acquire a certain size they want larger water, and they have to get it. My advice to those who have

such streams and wish to stock them, is to dig deep holes in the small streams such as are convenient to their places. Dig a hole which will have a curve in it, with no square shoulders in it. I would put something in the stream where fish could hide—logs or brush—so that they could have some sort of cover. One great thing in stocking streams is to be careful not to put in too many fish. You must govern yourself in stocking streams as you would in putting cattle into a pasture, or more will die than live. The food that the fish live upon must also be taken into consideration in stocking the stream. In putting spawn into a pond and allowing them to hatch there soon after impregnation, these spawn would not hatch unless there was a spring directly under them. If there was a spring and they were placed in carefully, the spawn would hatch, but if there was no spring to carry off the sediment as it came up through the gravel the sediment would kill the spawn.

As to percentage of loss mentioned in Mr. Porter's paper, it was not larger than was generally supposed. In old times such a loss was possible. I kept this year only one thousand young trout, and I raised 75 per cent. until they were a year old. The great thing is to have cleanliness in the apparatus you raise the fish in. All food thrown in for the fish to eat that is not consumed goes to the bottom, and there it becomes foul, and the fish soon sicken, and when they sicken they die. The way to prevent this is to keep your troughs clean. My troughs are cleaned every day perfectly clean, and during the last few years we have made a great success in raising our fish.

THE PRESIDENT: Mr. Green, Mr. Porter states that only 80 to 85 per cent. of all the eggs will be impregnated.

Mr. GREEN: I think we can do better than that. We

have counted the eggs and fish carefully, and I think that in the New York State Hatching-House we impregnated 95 per cent., and I think our work will show.

THE PRESIDENT: You mean you hatched 95?

MR. GREEN: He hatched 95 per cent. We have now 1,600,000 brook-trout that we expect to distribute in this state during this coming spring. This year I had the most favorable reports from the streams we have stocked. There was one little stream where I had placed three thousand trout. It was three-quarters of a mile long. I visited it last week. I could see that the stream was perfectly alive with the little fish two to three and a half inches long.

THE PRESIDENT: Mr. Porter says that after three years you would have but 5 per cent. of fish.

MR. GREEN: I would not hesitate to say that with fair usage 50 per cent. would be as small a number for good trout, if planted in proper water. I know that in these streams I have stocked there are to-day 80 per cent. of fish in as good condition as I put them in.

THE PRESIDENT: It seems to me that the proportion of loss given by Mr. Porter is very great.

MR. GREEN: I think it is. For the last three years we have never had any trouble in raising any kind of fish. We have salmon-trout now, five years old, in our works, and weighing ten pounds, and a great many of them. We have Kennebec salmon five years, and not any of them weighing over two pounds. The first, second, and third years they grew, and then seemed to stop. We have California brook-trout, two years old, that are certainly twice as large as our brook-trout the same age. They are a tough, hard, gamy little fish, and we raised them in the same way as any other fish, without the least trouble. They

are the smartest, gamiest fish I know of. That is the mountain trout of California. They do not differ in appearance from our fish in shape. They may be a little thicker about the head. They are handsomely colored, but have no red spots, but black spots, with square head, the same as ours. Some of the flesh is red, some white, just like ours.

By a Member: Suppose you were furnished with the eggs of the California salmon from year to year, and raised them in fresh water, would they produce more pounds of fish in weight than our brook-trout?

Mr. Green: Decidedly they would.

By a Member: Which would produce the greater quantity of fish in weight—the California salmon or the brook-trout?

Mr. Green: The California salmon, decidedly.

The President: About what proportion would be the increase—the comparative increase?

Mr. Green: At least one-half.

Question: The California salmon would be one-half heavier?

Mr. Green: Yes.

Question: Would they breed?

Mr. Green: They never would with us. I never have taken spawn from them. The egg is cast at one year old. I have impregnated trout with the California salmon, brook-trout and salmon-trout with the California salmon, with one year old California salmon.

The President: You did not get eggs of the female or milt of the male?

Mr. Green: Yes, I did.

In answer to a question in regard to grayling, Mr. Green said: I have brought grayling home, but they have never

cast any spawn. There seems to be something we do not understand about the grayling. I do not think grayling are proper fish for our latitudes. Perhaps the food has something to do with it. I am of the opinion that spawn could be taken from them and impregnated, and the fish live. They are too tender, like white-fish. I may remark that the great thing in taking spawn is to be careful and not rub off the slime on the fish. The slime on certain kinds of fish seems more than skin deep. You can take a trout and cut a deep gash across him, and he will get well; but take any other fish and run your hand round him, and he is a dead fish.

By a Member: Will you give us some information about pickerel?

Mr. Green: I have never taken pickerel from one water and put it into another. I never have taken pickerel on account of the prejudice against them. The pickerel is a dangerous fish to put anywhere.

By a Member: Have you ever had any experience with the silver-belly trout?

Mr. Green: There is a trout in the North Sebagoe Lake, which is a peculiar trout. I was shown some of them. They belong to the salmon-trout family, but are different from any salmon-trout I ever saw. In most lakes they differ a little, but these were a great way off from anything I ever saw. Their mouths are sharp. They were from a lake in this state, just north of Syracuse. They run up the month of July and spawn, and they resemble the salmon more than the trout.

By a Member: Have any continued efforts been made to transport the grayling from the West to our waters?

Mr. Green: No continued effort. Returning to salmon, I

think it very likely all the salmon family would spawn in a lake if there was plenty of gravel and a large spring coming out of the lake. Whether they all go up those streams we do not know, but the chances are that nearly all do so.

By a Member: Referring to Mr. Porter's statement, it is something new to say that in five years' time only 5 per cent. of eggs are left in a good state; but in the paper there is a saving clause. He says he started out with one hundred thousand eggs, and further says that with a small amount of eggs, such as twenty thousand, a greater proportion would be saved. I want to ask if he did not have too many eggs?

Mr. Green: Well, almost all of us could handle $20,000 better than we could $500,000; but we have men, of course, who handle great sums of money pretty successfully.

Mr. Reeder, Fish Commissioner of Pennsylvania: The overstocking of water is an evil much to be dreaded. The loss in cases of fish put into the water, where water has insufficient food, arises from consumption of the fish by the other fish. That applies more particularly to trout, which are a good deal like men: they feed upon other trout. That is the distinction between sheep and trout. Trout will eat each other, and sheep will not; and the excess is consumed as food, and consequently it is to be apprehended that in a large number of fish the loss will be larger. When they get sick, the big ones eat the little ones, and they then become diseased, and when the disease seizes upon them it goes through the whole family, and only a few recover. We have no way of doctoring them. They get thin, and nearly all die. A very much larger percentage would die if put in the water in large quantities. There would be danger in introducing a

large number in a small pond, as there would in putting a large number of men in a small room.

MR. GREEN: Our streams can nearly all be improved by introducing food. My experience is, that when fish sicken most of them die. We bathe them with salt, and do many things, and once in a while save some. We have what we call a hospital, and go through operations and doctor them, and sometimes save them.

MR. MATHER: In regard to moving fish at spawning-time I can give my experiences. I had two hundred fish ready to spawn. I removed them to a fitting locality, and they never spawned. I have moved the fish from one locality to another about the spawning-season, and found that these fish were barren. I would advise persons who wish to distribute fish, not to do it just about the time they are going to spawn.

MR. GREEN: The grayling I spoke of had spawned.

MR. MATHER: Those I refer to had not spawned. The next year I took the spawn from the living fish, and I think I can bear out Mr. Green's assertion there again that they will not live after they have spawned.

MR. GREEN: We are hatching the frost-fish, too. Some four men have taken some hundred thousand of them. We hatch them the same as whitefish.

THE PRESIDENT: Would Professor Milner give us the scientific name of the frost-fish?

(Some smelts were brought in from Fulton Market.)

MR. MILNER: That is the smelt—the fresh-water smelt.

The President asked whether it is Mr. Milner's opinion that the Raritan smelt is the same as the fresh water one.

MR. MILNER: I would not like to say that.

MR. BLACKFORD: We have at the market smelts that come

frozen from Nova Scotia, and many of them are peculiarly black on the backs. We call them black-backs. We obtain from Massachusetts and Maine green smelt, which term means that the smelt has not been frozen. We have sent us the Raritan and Passaic river smelt, which are very small, indeed, but are considered very choice by the people in that vicinity, though they would not be appreciated in the New York market, because of the size. In New York the larger the smelt the better the price.

THE PRESIDENT: Do you consider, from what we find in the Report of the Maryland Commissioners, that there are two varieties?

MR. MILNER: Mr. Norris had named a certain species *osmerus sergentii*, but I have not made a critical study, and I am not prepared to reply. I could not give any precise conclusions, unless I obtain specimens of the different varieties from different waters, and had studied them carefully.

A member from Newark, N. J., said: In Newark, New England smelts sell at five cents a pound, and smelts taken from the river, at Newark, at twenty-five cents. I do not know whether there was really twenty cents difference, but purchasers thought so in Newark. I have eaten the Raritan smelt the same time as the other smelt, and thought that, according to my judgment, there was twenty cents difference. The Raritan smelt was a very much more delicate fish.

MR. BLACKFORD: Would you not find the flavor of all smelts delicate if you took them the same size?

A MEMBER: As to the Raritan and Passaic smelt, people seldom eat them, unless they are very fresh, which makes a great difference.

MR. BLACKFORD: The best smelt we get in Fulton Mar-

ket, and those which bring the largest price, are smelts caught in some little inlets of Long Island, Patchogue, and other places—smelts which average five to a pound. They are caught in the afternoon, and we get them next morning, and the flavor is considered superior to anything in the market. Speaking of the Raritan smelt, the fish commissioner of New Jersey brought up a small basket at the time of the opening of the trout season last year, on March 15th, and quite a number of gentlemen of this Association were present and ate them, and everybody thought them the finest smelts they ever ate.

MR. GREEN: The fact is that the fish caught right at your homes is the best fish you ever ate. I think the difference is due to the time they are out of water. When I go to market I inquire for the freshest fish they have.

BY A GENTLEMAN PRESENT: I find that this same question of excellence applies to shad. When I go to the South I find there is nothing like the shad there, and the same in the North. People in this state talk of North River shad. People in Philadelphia swear by Delaware shad.

Mr. Milner then read a paper by Mr. LIVINGSTONE STONE on packing and transporting salmon-eggs.

REPORT ON THE GENERAL SUBSECT OF THE PACKING AND TRANSPORTATION OF SALMON-EGGS.

One of the features of the culture of the salmon family, which has contributed without doubt more than anything else to its efficiency and wide-spread usefulness, is the fact that it is possible to transport the eggs of the salmonidæ

alive over very long distances.* The California Salmon-Hatching Station of the United States Fish Commission furnishes a good illustration of this. From this station salmon-eggs are sent alive to points sixteen thousand miles apart. The sphere of usefulness, therefore, of the California establishment has a radius of eight thousand miles, which enables it, theoretically, to inclose within reach of its beneficent influence an area of two hundred million square miles.

This shows how immensely the possibility of the wide distribution of salmon-eggs increases the utility of the efforts that are being made in the culture of salmon.

Another circumstance about the distribution of salmon-eggs which deserves mention, is that it is no longer experimental, as was once believed. It was thought not very long ago that when salmon-eggs were sent to a distant point it was a mere matter of luck and chance whether they reached their destination alive. It is not so at all. The principles involved are so simple, and the rules of packing and transportation are so clear and so certain in their action, that if salmon-eggs are lost in the course of a month's journey, it is because of ignorance or carelessness in the packing or in the care of the eggs in transit, and is not a question of luck or chance at all, *except* in this particular, viz., if you are obliged to let the eggs go out of your hands, then it becomes a matter of chance whether the express agents or others in charge of them will faithfully carry out their instructions. As a general thing, they do not.

* The longest distance ever successfully overcome in the transportation or fish eggs, I believe, was between Charlestown, New Hampshire, and Christchurch, New Zealand, being upwards of eleven thousand five hundred miles. This was in the case of a lot of "Salmo Fontinalis" eggs, which were shipped from New Zealand by Messrs. Stone and Hooper, Charlestown, New Hampshire, in the fall of 1876.

When the rules for packing and transportation are faithfully observed, you may be just as sure of finding your salmon-eggs alive at the end of a ten thousand mile journey, as you would be of finding your horse or your dog alive after a trip from Boston to New York. The element of uncertainty in the transportation of salmon-eggs has been entirely removed in theory. When it comes to practice, it depends, of course, on whether the conditions of safety can be secured and carried out; but when salmon-eggs are lost in a month's journey, it has been, not from any necessity for it, but because some of the rules for packing and transportation have not been observed.

The rules for packing salmon-eggs may be briefly stated, as follows:

(1.) *They should be packed at the right age.* The right age is just when the choroid pigment, or eye-spot, as it is commonly called, shows as a clear, distinct black spot through the shell of the egg. The reason why this is the right age is because the embryo, previous to that stage, is too delicate to bear the journey, and every day after that stage is reacted, the outer shell of the egg becomes more and more fragile, and consequently less able to stand the pressure to which it must be subjected in packing. See Rule No. 5.

(2.) *The eggs before being packed should be washed perfectly clean,* so that every pore will be able to do its best service in the severe trial which is before them. It is evident if the pores of the eggs are half stopped up with dirt, or half covered with fungus, it is in no condition to survive the ordeal of a long journey in a packing-box. I will not reflect upon my reader's intelligence by saying that the eggs must be healthy eggs to begin with, but will say

that if their vitality has been weakened by sediment, fungoid growths, attacks from water-insects, or any other causes whatever, they had better be kept where they are. They are certainly not fit to be packed for a long journey.

(3.) *In packing, use as far as practicable fresh, living moss.* This is very desirable, indeed, as the live moss takes up the effete exhalations from the eggs, and in return furnishes oxygen to sustain the life of the embryo. Indeed, so serviceable is living moss in this respect, that fish-eggs packed in it can be enclosed in a perfectly air-tight package safely for a long time.

(4.) *Use clean moss*, from which all extraneous matter, such as sticks, dead leaves, and the like, have been removed. Decaying vegetation or hard substances can do the eggs no good, and may do them harm.

(5.) *The eggs should be packed very tightly.* There is very little danger in your exerting too much pressure on them if they are taken at the right stage, and if moss and eggs are all right to start with. In packing the California salmon-eggs, which have made the journey successfully from the Pacific to the Atlantic so many times the last few years, the moss is piled up an inch or two above the top of the packing-boxes, and then the covers are forced down to their place by a very strong pressure. If the eggs are healthy, and packed at the proper stage, it will not injure them in the least, and the close packing, consequent upon this pressure, *will keep them in their place*, which is one-half the battle. If you are afraid the egg-shell will not bear the pressure, try to squeeze a healthy salmon-egg between the thumb and finger when the eye-spot first shows, and see how much pressure it will stand before the shell breaks.

(6.) ***Protect the box of moss which contains the eggs from changes of temperature*** by a competent outer packing of sawdust, or some other non-conducting material, to keep the heat or extreme cold to which the package may be subjected from reaching the eggs within.

(The author thinks that moss is the best material for the outer packing, but does not here insist upon it.)

(7.) When exposure to warm air is to be guarded against, ***it is necessary to provide ice-chambers*** in the outer packing-boxes. As this is merely a question of mechanical contrivance, I will not enlarge upon it here any further than to say that the ice-chambers should be so arranged that the water and the cold coming from the melting ice should be allowed to descend upon the eggs.

(8.) ***By all means, if ice is used, have apertures in the top and bottom*** of the egg-boxes to let in and let out the water caused by the melting ice. The openings at the top let the ice-water in to the eggs, which cools and refreshes them; while, on the other hand, the openings at the bottom let the water out, which is absolutely indispensable, as there is nothing more surely fatal to salmon-eggs than stagnant water.

If the above directions are carried out, it makes very little difference what the size of the packing-boxes is, or the shape or the material, provided they are clean, strong, convenient, and suitable for general packing purposes, it being desirable only to remember that the depth of the boxes containing the moss and eggs should not be over six inches.

For the benefit of inexperienced amateurs in fish-culture I will repeat the programme for packing eggs, so well known to all professional fish-culturists, viz.: Place at the

bottom of the box first a substantial layer of moss, then a piece of mosquito-bar the size of the box, then a layer of eggs, then another similar piece of mosquito-bar, then a layer of moss, then mosquito-bar and eggs again, and so on to the top. The layers of moss should be thick enough to effectually prevent the adjacent layers of eggs from touching each other, and this is about all that is necessary. The top layer of all should be considerably thicker.

Transportation of the Eggs.

The whole secret of the successful transportation of salmon-eggs lies in observing this one rule, viz.:

(1.) keep the eggs cold.

By cold, I mean as near the freezing-point as they can be kept without freezing. I cannot emphasize this point enough. If you pack the eggs properly, and keep them cold enough, you are perfectly certain, with the exercise of an ordinary amount of common sense, leaving accidents out of account, to take them safely a month's journey. There is no chance or uncertainty about it. Indeed, it is safe to say that if it were practicable to keep the temperature at 33 deg. Fahrenheit, you could take salmon-eggs around the world alive. On the other hand, if you let them get warm, you are perfectly certain to lose them.

This was undoubtedly the cause of the loss of the shipments of California salmon-eggs to Europe in the fall of 1877. At some point between Sacramento and Liverpool the eggs, not, of course, through any conscious neglect of the messenger in charge, but undoubtedly without his knowledge, were allowed to get warm, and, as a necessary consequence, were lost. The disaster could not have resulted from

the packing, because a larger lot, sent at the same time and packed in the same way, accomplished the journey of eight thousand miles, and across the tropics to New Zealand in safety, and proved a triumphant success, only 5 per cent. being killed in transit.

In the observance of the above rule lies the whole science of the transportation of the salmon family.

If from accident or otherwise the eggs should get warm or dry, drench them copiously with ice-water. If they have not already suffered injury, this will set them all right again for a new start. I need not add that the packing-boxes should never be allowed to ride on end, but should always be right side up or the reverse.

If fish-culturalists would take pains to pack their salmon-eggs according to the rules given above, and would make sure of carrying out of the one rule for transportation, viz.: *keeping the eggs cold*, there would be no more of the very annoying losses of eggs which have so frequently occurred.

AFTERNOON SESSION.

THE PRESIDENT: The subject of the hatching and transporting the spawn of California salmon, as suggested by Mr. Stone's paper, is now under discussion.

MR. REEDER: In regard to the subject of dry impregnation, that it had been discovered by Mr. Green in the course of his experiments, who was able to obtain 80 to 90 per cent. impregnated eggs. For a long time Mr. Green kept this a secret. I do not know why it is referred to as the Russian method. If the Russians have adopted it, it certainly has been since its discovery by Mr. Green, but the credit of its discovery belongs to Seth Green, and not to Russian sources.

MR. MILNER: The first published report on the subject was made by Mr. Atkins, and in the second Report made by the United States Commissioner, in referring to the subject, it was credited to Mr. Atkins. But in a translation made and carried into the same volume it was found that the fish-culturists in Switzerland had practiced the same thing with some success, and that the credit was due to these Swiss.

THE PRESIDENT: The first report was made by Mr. Page.

MR. GREEN: In October, 1864, I took some spawn of the trout, and used the method that everybody else had tried as far as I had heard. I took the spawn in a vessel, and filled it one-third or one-half full of water, and then stripped the spawn into the water, and then stripped the milt in, and then stirred it with the fish's tail; that was the old style. That was all that was known of it when I commenced. Well, I kept on taking spawn for sixteen days. The temperature of the water I used was 51 deg. or 52 deg. At the end of sixteen days I could tell which eggs were and which were not impregnated. I counted several hundred spawn, and found 25 per cent. impregnated. I told this to a gentleman who came to see me, and he said, "That is as good as was ever done in any country." I said, "If that is the case, I will not stay in this hatching-business very long, because I cannot take out 75 per cent. of these spawn." At night I thought it over. In the mean time I examined the milt of the male under a microscope, and watched the little animalculæ, and supposed that in their movements they went into the egg. I said to myself, "Suppose I do not use so much water; suppose I do not use any at all." Next morning I got some spawn and milt, and did not use any water, but sifted it down and covered it

all over with milt, and let it stand five to eight minutes, and then added a little water to it, and in about ten to fifteen minutes more added a little more water, and at the end of half an hour washed them off and put them in the hatching apparatus, and in sixteen days I counted hundreds and hundreds of spawn, and had 95 per cent. impregnated. I did not tell everybody about it for three years. My discovery was in October, 1864.

Mr. Milner claimed the credit for Mr. Atkins as having been the first to publish the method referred to.

MR. MATHER, in response to the President's call, said: I wish to say a word in connection with the reading of Mr. Livingstone Stone's paper. Mr. Stone says "that in the fall of 1877 eggs were sent to Europe, and did not turn out well. The probability is that the person having the eggs in charge did not keep them cool." I was the man who had the eggs in charge. What Mr. Stone says is true, but if the eggs could have been kept at the temperature which he names (30 deg.), he says they would have gone over admirably. The facts are these: I was requested by Prof. Baird, the United States Commissioner, to go over and take care of these eggs. I arranged my own plan, which was to take them over on flannel trays, with an ice-chambe on top. I had some little experience in going to sea with fish, and knew some of the difficulties. I was aware that on board ship you have to conform to the regulations, and do as you are told, right or wrong, and your things are moved in case of a storm or anything without consulting you. I did all in my power to keep the eggs at the proper temperature. It was proposed to put me near the engine, the only place they could find. The North German Lloyds were very liberal in giving facilities of transportation free

of charge. I found that the proposition Mr. Milner made to me to take the hatchway on the main-deck and put it in a load of straw, and pack the eggs in a ton of ice, was not practicable, because straw would not be allowed in the hatchway. I had to go into the hatchway and rely upon putting cakes of ice on top of the packing, and let it drip through, which I did. I had two tons of ice, and I have my record here of the air in the hatchway, which ranged from 56 deg. to 74 deg. Seventy-four degrees was the highest on the 9th of October. In the box that I had the temperature ranged from 48 deg. to 55 deg., and on every day the eggs were in splendid condition. There were not more than 300 dead eggs out of 25,000 which I took over in those boxes. At the last moment the order came for me not to unpack the eggs. Mr. Stone said that contact with the air would hasten the hatching, but Mr. Stone, not knowing the temperature of the air in the ship as well as I did, I was a little annoyed about it. * * I had one box packed in my own method, and I could keep them cool and get them over. The others were almost, if not totally, lost. Since then the eggs of whitefish and land-locked salmon have been sent. I received the eggs in New York One lot was sent to Germany. The last lot they proposed to put in the life-boat. I had little confidence in any of these going safely. There was to be sent by the French line of steamers a box of eggs to the *Societe d'Acclimation* of Paris. The French steamship company stated in a letter that they would have the eggs put in a room made for the purpose of carrying fresh meat to France. I have no doubt they will go that way quite well. It is a question, as Mr. Stone says, of temperature, and it is impossible to control this temperature at sea, unless you are in such a position as I have just described in the French

ship. In the ordinary hatchway, at sea, when a storm commences, the hatchway must be closed, and no matter how hot it is, still it must be closed, and you are paid no attention to, because the safety of the ship is more important than the eggs, and even with it open and the eggs exposed to the temperature in October, it would range so high that it would be impossible to keep them.

MR. MILNER: A shipment of spawn to New Zealand was made from California very much better than that Mr. Mather describes, in the German ships. The New Zealand mail-ships afforded the best facilities for transporting the spawn, and before the ships left San Francisco there was an ice-house arranged for the purpose of taking in the boxes of spawn. The requisite temperature was sustained from San Francisco outward, so that the point made by Mr. Stone in reference to keeping them cool was possible to be carried out. The proposition in the start was that the hatchway be taken, and that a floor be made about the lower deck, covering the space of the hatchway, and then that a heavy layer of straw be placed on a layer of ice, and the box placed on that, the ice being packed round precisely as in an ice-house; but the company refused to take the straw on board, so that the ice had to be placed in a comparatively warm hatchway, where it melted away.

MR. MATHER: My ice was placed in the ice-room under the care of the provision steward. His room is in the extreme lower part of the ship, away forward. The eggs were nearly midships in the open hatch, and I had men go down there every day and bring me up ice in large cakes, which I would place on top of the eggs and let it drip down through. I have given a complete report of the whole business to Professor Baird, and it will undoubtedly be published

in his report. In regard to going to sea with eggs, I find there is so much difference in ships, that if I were going again, I would like very much to look over the ships and make a selection, even though it took some time, because in some vessels you might have the facilities you want and in some you might not have them.

THE PRESIDENT announced the next section: "Fishery Laws and Fish-Ways."

Letters were presented from Mr. Stone and Mr. Everts, stating their inability to be present. No report from this section was therefore presented.

THE PRESIDENT announced the next section: "Natural History."

PROFESSOR J. BROWNE GOODE, of the Smithsonian Institute, Washington, D. C., read a paper on the "Migration of Fishes."

INTRODUCTORY NOTES.

The following paper should be regarded simply as a preliminary sketch of an investigation which I hope in future to pursue. The notes were prepared while attempting to gain some insight into the migratory habits of the menhaden. The habits of this fish and the mackerel are somewhat similar, and this circumstance led to the discussion of the various theories to account for the movements of the mackerel, which if admitted in one case, must needs be in the other. The subject is a very broad one, and one which deserves careful study from many standpoints. The material at my disposal, though not large, has not been utilized to its full extent.

I. THE MIGRATORY HABITS OF FISHES.

I. THE MIGRATIONS OF FISHES AND BIRDS COMPARED.

It was formerly believed that all seasonal migration was directed toward and from the equator, but zoologists of the present day recognize another kind of migration quite as important, although usually not so extended. At the approach of the hot season in sub-tropical climates the birds seek a cooler temperature, either by flying northward or by ascending the high mountains. In like manner the fishes of any region may find water of suitable warmth by moving north or south along the shores of the continent, or by changing to waters of less or greater depth. The former may be called equatorial migration, and the latter bathic migration.

II. BATHIC MIGRATION.

Bathic migration is the most common. The cod family, the halibut and flounders, the scuppaug, tautog, sea-bass, and sculpins, are well-known examples. The cod prefers a temperature of from 35 deg. to 42 deg. F., and this it secures in a temperate climate, such as that of Southern New England, by remaining on the off-shore banks in 15 to 35 fathoms of water, coming near the shore in winter, On the coasts of Labrador, Newfoundland, Nova Scotia, and Eastern Maine they are near the shore in summer, and in deep water in winter. In Norway they are caught, to some extent, in the fiords in the summer season, though never in winter: in summer they still remain on the off-shore banks. The halibut move up and down on the sides of the great oceanic banks and the continental slopes with the seasonal changes of temparature: in the summer they are abundant in the shallows of South Greenland, while in winter they are in deep water. On the coast of Massachusetts they

come near the shore only in dead of winter, though abundant in summer on the edge of the outside banks in 80 to 300 fathoms of water. The sand-dabs (*Hippoglossoides dentatus*) are abundant in July, in water of 60 and 80 fathoms, ten miles off Cape Ann. In the middle of winter they swarm upon the sand-flats in water of 2 or 3 fathoms depth.

III. NOMADISM AND EQUATORIAL MIGRATION.

The Spanish mackerel, the bonito, and the tunnies are good examples of nomadic species. In summer they throng our northern waters; in winter they are under the tropics. Others, like the sea-herring, appear to migrate in two ways. Their movements are approximately both parallel with and vertical to the coast-line; that is to say, they secure changes of temperature both by leaving the upper strata of the ocean, and by moving toward and from the south. The researches of Boeck in Norway show that the schools approach the coast by gullies or submarine valleys from the oceanic depths. Such is doubtless the case on our coast, in their earliest approaches, though having reached the shallows near the shore, the schools range along great stretches of coast-line. Since fishes have no restrictions upon their movements, except those of food and temperature, all active species must traverse areas of many hundreds of miles during the year.

IV. THE VIEWS OF RECENT INVESTIGATORS.

The tendency of all the researches made during the past few years have been to confirm the views advanced by Professor Baird, in an unpublished letter, written in 1873, to the Hon. Hamilton Fish, Secretary of State. "The question in regard to the migration of fishes is one that has attracted the attention of both fishermen and naturalists for many years

past. and a great deal of eloquence has been expended by Pennant and other writers in their history of herring and other species. For many years it was considered beyond question that the sea-herring, having their homes in the northern seas, were in the habit of prosecuting extensive journeys, in the course of which they successively visited the shores of Europe and America, penetrating into their bays and sounds, and returning afterward to the point from which they started; the adults decimated by the predaceous fishes and their capture by man, but their numbers kept up by the progeny, the result of their spawning operations, for which purpose it was supposed their journeys were initiated. In the same manner the shad and the fresh-water herring of the American coast were supposed to start in the late winter along the southern coast of the United States in a huge column, the herring first, and afterward the shad, first entering the St. John's River in Florida, and while passing up the coast sending off detachments into all the principal rivers, and finally stopping in about the latitude of the mouth of the Gulf of St. Lawrence.

This theory is at present almost entirely abandoned, and there is reason to believe that after the herring and shad have spawned in the rivers, they proceed to the sea and spend the period until the next anadromous movement in the immediate vicinity of the mouths of the rivers, where they are followed in due course of time by their young.

This is illustrated by the fact that fish of nearly every prominent river show some peculiarities by which both the fish-dealer and the naturalist can distinguish them; the difference not being sufficient to constitute a specific rank, but such as to mark them as local races. Numerous captures, too, in gill-nets and otherwise, off the northern coast, during

the period when they should be gathered together in the southern waters, prove that a portion at least remain. It is difficult to imagine how a shad or a river-herring, spawned in the St. Lawrence river or any northern stream, could avoid entering a more southern river, if in its vicinity; but if any fact has been well established of late years in the history of fishes, it is that the anedromous fish, or such as run up the rivers from the sea to spawn, will return, if possible, to the river in which they first saw the light. So true is this, that where there may be two or three rivers entering the sea in close proximity, which have become destitute of shad or herring, in consequence of long-continued obstructions, and the central one only has been restocked by artificial means, the fish, year by year, will enter that stream, while those adjacent on either side will continue as barren of fish as before."

II. THE INFLUENCE OF TEMPERATURE ON THE MIGRATION OF FISHES, ILLUSTRATED BY A STUDY OF THE PERIODICAL MOVEMENTS OF THE SCHOOLS OF MENHADEN.

I. COMMENTS ON THE TEMPERATURE TABLES USED.

The influence of ocean temperature on the menhaden is not at all well understood, and I can here record only crude generalizations founded upon very unsatisfactory data. I have before me three tables, showing the variation of temperature by monthly means for Key West, Fla.; Jacksonville, Fla.; Savannah, Ga.; Charleston, S. C.; Wilmington, N. C.; Norfolk, Va.; Baltimore, Md.; New York City; New London, Conn.; Woods Holl, Mass.; Portland, Me.; and Eastport, Me. Table I. shows the monthly means of surface temperature; table II. the temperature at the bottom near the shore, and

table III. the average means of surface and bottom temperatures. The observations were all made at 3 P. M., and are continuous from March 1, 1876, to March 1, 1877. They are reproduced at the end of this paper. There is also a table of the daily observations of temperatures at the same stations. A study of these tables, which for convenience were mapped out in curves on section-paper, afforded some interesting results.

II. MINIMUM LIMITS OF TEMPERATURE, AND THE DATES OF APPEARANCE AND DISAPPEARANCE OF SCHOOLS.

The monthly mean of surface temperatures at Eastport is greatest in September, when it is 50 deg. 6 m., while the highest daily observation is 51 deg. 5 m. The menhaden do not visit Eastport in midsummer.

Let us divide the monthly averages for May, at Portland, into quarterly periods. The average for May 16th to 23d is 47 deg. 1 m.; for May 24th to 31st is 51 deg. The quarterly month averages for October are 53 deg. 8 m., 50 deg. 8 m., 47 deg. 9 m., 48 deg. 8 m. The schools of mendaden arrive in Eastern Maine late in May and early in June, and depart usually before the middle of October.

At Woods Holl, the quarter-month's averages for May, as taken by the signal service observer, are 48 deg. 2 m., 49 deg. 6 m., 53 deg. 1 m., and 57 deg. 6 m., approximately or the monthly average, 52 deg. 3 m. These observations are made in the Great Harbor at the railroad wharf. Another series of observations, made by Captain Edwards for the Lighthouse Board, in the Little Harbor, are believed to indicate more nearly the temperature of the Vineyard Sound. These, however, are only for bottom. The difference between the monthly mean of bottom temperatures for May, at the two stations,

is almost two degrees (1 deg. 8 m.), the figures being 51 deg. 5 m. for Great Harbor; for Little Harbor, 53 deg. 3 m. It does not seem assuming too much to place the quarter-month average for the first half of May at 50 deg. and 51 deg. 4 m. For November the Great Harbor quarter-month means are 51 deg., 51 deg., 51 deg., 47 deg. 7 m., 43 deg. 3. The menhaden strike into Vineyard Sound early in May or late in April, and linger until November and even December. At New London the quarter-monthly averages for the last half of April and the first half of May are 49 deg., 48 deg. 5 m., 52 deg. 5 m., 54 deg. 5 m.; for late October, 55 deg. 2 m., 54 deg. 9 m.; for November, 53 deg. 5 m., 51 deg. 1 m., 48 deg. 1 m., 46 deg. 1 m. The fish come on the eastern coast of Connecticut late in April, and are frequently taken as late as the middle of November. The temperatures of New London suggest that there may be something in error in the Woods Holl observations, in so far as they are supposed to indicate the temperature of the ocean in its vicinity. The periods of appearance and disappearance at Waquoit and Menemsha, in the Vineyard Sound, agree nearly with those of Eastern Connecticut.

The temperature of the Chesapeake must be studied from the observations made at Baltimore and Norfolk. At the latter place the April means are 52 deg., 56 deg. 5 m., 61 deg. 2 m., 60 deg.; the November means are 59 deg., 54 deg. 6 m., 53 deg. 5 m., 48 deg. 5 m.; at the former for April, 45 deg 6 m., 50 deg., 54 deg. 5 m., 55 deg. 7 m.; for November, 54 deg. 2 m., 52 deg. 1 m., 50 deg., 47 deg. At Norfolk the averages for the last half of March are 48 deg. and 50 deg.

The movements of the menhaden in more southern waters have not been very carefully observed, but we know that they enter the Potomac late in March and early in April, and

that they linger till the last of November. In 1874, the young menhaden lingered in the lower Potomac until the middle of December. In 1876, the average for December surface temperatures at Norfolk was 36 deg. 8 m.; for bottom temperatures, 36 deg. 4 m. In 1874, the average surface temperature for December at Norfolk was 43 deg., or 6 deg. 4 m. higher than in 1876—the year for which our tables of observations are made up. The average for Norfolk surface temperature in November was, in 1876, 53 deg. 4 m.; in 1874, 55 deg. 1 m., or 1 deg. 7 m. higher. It is quite probable that in 1874 the water of the lower Potomac did not become colder than 50 deg. until December.

At Wilmington, the monthly means of bottom temperatures in 1876 and 1877 were, for December, 43 deg. 1 m.; January, 43 deg.; February, 48 deg. 5 m. In 1874 and 1875, December, 48 deg. 1 m.; January, 43 deg. 8 m.; February, 45 deg. 5 m. December, 1876, was unusually cold, the mean temperatures of the air being 46 deg. 3 m., against 59 deg. 1 m., for the same month in 1874. January and February of 1874 were relatively cold, the air temperature being 48 deg. 1 m. and 53 deg. 1 m., against 57 deg. 1 m. and 52 deg. 5 m., in 1876. The surface quarter-month averages for the last half of February, 1877, are 49 deg. 1 m., 50 deg. 5 m.; for the first half of March, 1876, 52 deg. 6 m., 57 deg.; for late November and early December, 1876, 57 deg. 1 m., 53 deg. 6 m., 46 deg. 6 m., 45 deg. 3 m.

No observations have been made upon the movements of the menhaden at Wilmington. At Beaufort, 30 miles further north, they appear to be absent during the winter. It is much to be regretted that there are no temperature observations from Cape Hatteras. The relations of this locality to the Gulf Stream are peculiar, and corresponding peculiarities in

the temperatures no doubt exist. The hundred-fathom curve is distant about 40 miles from the point of the Cape, and the average summer limits of the Gulf Stream, as laid down upon the British Admiralty charts, extend nearly to this curve. The observations made at Wilmington, situated as it is in a bend of the coast, at least 100 miles from the summer limits of the Gulf Stream, and at the mouth of a river which rises 200 miles away in the elevated central portion of North Carolina, can hardly be taken as criteria of the temperature of Cape Hatteras. This is still more unfortunate from the fact that the movements of the menhaden, blue-fish, sea-trout, and other warm-water species, are very peculiar at this point. It will be strange if the monthly mean of water temperature for Cape Hatteras, in December, and perhaps January, does not prove to be more than 50 deg. Savannah is at least 120 miles from the Gulf Stream, and its means for December and January, 1876–1877, as well as those of Charleston, are below 50 deg. Charleston water appears to be uniformly warmest. In 1874, December, in Charleston, averaged 48 deg. 8m.; in 1875, January averaged 50 deg. 2 m. The movements of the menhaden in this region have not been observed, but since in the north it is not more hardy than the shad, and since the shad do not venture into the Georgia and Carolina rivers in December, it is safe to predict that the habits of the menhaden are similar. Jacksonville, Fla., is the only point on the coast from which there are observations showing a temperature uniformly above 51 deg., and here menhaden remain throughout the winter.

III. MAXIMUM LIMITS.

On the coast of Eastern Maine we are told that the menhaden schools keep passing to the eastward until about the

middle of July, when their impetus is apparently checked, and their movements for thirty or forty days seem to be local only. During this period the temperature at Portland varies from 60 deg. to 70 deg., this being the height of midsummer. The monthly means for July and August, 1876, were 66 deg. 7 m., and 63 deg. 9 m. The same months at New London are placed at 73 deg. and 73 deg. 3 m.; at Norfolk, 84 deg. 1 m.; June, July, and August, at Jacksonville, average above 85 deg., and we have no satisfactory evidence that the menhaden are seen there in midsummer. At Key West the lowest monthly mean is in December, at 66 deg. 4 min., in an unusually cold winter.

IV. PREFERRED RANGE OF TEMPERATURE.

These facts seem to indicate that under ordinary circumstances the menhaden prefers a temperature of 60 deg. to 70 deg. Fahrenheit. When the rising temperature of spring has passed the limit of 50 deg. to 51 deg., the fish are certain to appear; and when the falling temperature of autumn reaches that point their departure is equally sure, though a few individuals may linger in water not congenial to them. The opposite limit seems to be marked by the line 80 deg., or perhaps 75 deg.

An easterly or northerly wind, lowering temporarily the surface temperature, causes the school to sink below the surface. The chill of night also drives them down.

These conclusions are not to be regarded as final. The movements of the fish about Cape Hatteras are very puzzling, and need to be interpreted by a series of careful temperature observations.

III. A STUDY OF THE THEORIES WHICH HAVE BEEN ADVANCED IN EXPLANATION OF MIGRATION OF FISHES, WITH ESPECIAL REFERENCE TO THE MENHADEN AND MACKEREL.

I. THE WINTER RETREAT: THREE ALTERNATIVES.

The relations of the temperature of the water to the movements of the menhaden schools having been studied, a new question is at once suggested. When the schools disappear from our coast, driven by falling temperatures, where do they go? The answer must be in the form of a theory, for no one has seen them during their winter absence—at least no one has been able to identify the New England and Middle States fishes after their departure in the autumn. It is evident that there are but three courses open to our coast-fishes when it becomes necessary for them to leave inshore:

1. They may swim out to sea until they find a stratum of water corresponding in temperature to that frequented by them during their summer sojourn on our coast.

2. They may swim southward until they find water of the required warmth.

3. They may descend into the abyssal depths of the ocean, there to remain for a season in partial or total torpidity.

II. A DISCUSSION OF THE ARGUMENTS FOR AND AGAINST HYBERNATION.

The last of these theories is the least plausible, from the fact that it necessitates the greatest change in habits. The susceptibility of the menhaden to slight changes of temperature has been pointed out. Hybernation in the oceanic depths involves a change to water ten to twenty-five degrees colder

than that preferred in summer, as well as other important changes in respect to specific gravity and pressure.

The hybernation theory is a favorite one with the fishermen of the British provinces, and has recently received strong support from Professor Hind in his treatise on the "Fisheries of North America." His arguments refer to the mackerel, although the scup, tautog, and herring are included by implication. He refers to the appearance of the mackerel "with scales on their eyes, and blind," and suggests that the winter sleep of fishes is probably much more general than is usually supposed. He takes the position that there are only two alternatives possibly open to fishes which cannot live in cold water. They must migrate south or hybernate. His arguments naturally fall into two categories—those against migration and those in favor of hybernation. Those in favor of hybernation may be summed up as, first, the testimony of fisherman and travellers; second, the quoted opinions of theorizers; third, the alleged hybernation of other fishes; and fourth, peculiarities in early and late fishes.

(1.) The statements of one M. Pleville le Peley, "an eye-witness," are quoted both from Lacepede and H. de la Blanchere. M. le Peley gravely states that he had observed about the coasts of Hudson Bay "the mud at the bottom of the small, clear hollows, encrusted with ice around their coast, entirely bristled over by the tails of mackerel imbedded in it nearly three parts of their length;"* and again "affirms having seen in the middle of winter, in deep, muddy bottoms, myriads of mackerel packed one against the other, with one-half the body plunged in the mud, where they remained during the winter. As soon as spring came they aroused themselves from their torpor and appeared always on the

* Hind, op. cit. Part II., p. 10, note.

same day on the same coast at the surface of the sea, and repaired to favorable spots to spawn."* The absurdity of these statements renders it unnecessary to criticise them. The other testimony is less definite. A Newfoundland fisherman remembers to have heard his father say that forty years before "he had often seen mackerel in White Bay, come on shore like squid, with scales on their eyes, and blind, about Christmas;"† and again, a statement quoted from the Rev. John Ambrose that "mackerel have been brought up from the muddy bottoms of some of our outer coves by persons spearing for eels through the ice,"‡ which statement is not supported by the personal evidence of Mr. Ambrose, being merely a hearsay story. And this is all. Prof. Hind, in Part II. of the same work,§ remarks confidently, "That the mackerel spends the winter months in a torpid condition near to the locality where the school first show themselves on the coast has already been adverted to;" and again refers to "the fact already noticed that it is taken in winters from muddy bottoms." I submit that no such fact has been established, and that Prof. Hind's generalizations are without foundation. There is much better evidence to prove that swallows hybernate in the mud of ponds, a theory which has had numerous advocates since the time of Gilbert White of Selborne.

(2.) Prof. Hind first quotes from "La Peche et Les Poissons" of M. de la Blanchere. The statement, printed as it is in a single paragraph instead of two, and not given in full, conveys the impression that M. de la Blanchere indorses the

* Part I., p. 78. † Part I., p. 78.

‡ Observations on the Fishing Grounds of St. Margaret's Bay, N. S., by Rev. John Ambrose, in Proceedings and Transactions of the Nova Scotian Institute of Natural Sciences, 1866-7 quoted by Hind, op. cit. Part I., p. 79.

§ Page 10.

views of Pleville le Peley, already quoted. On the contrary, he states explicitly: "The question of the annual and regular appearance and disappearance of this fish is still unsolved." He then proceeds to contrast with M. le Peley's views of Duhamel de Monceau, Anderson, and others, who represented that the mackerel pass the winter in the northern seas, and in spring, beginning their migrations, pass Southward, visiting first Iceland, then Jutland, then Scotland and Ireland and the coasts of Continental Europe, in autumn assembling together for a return to the polar regions. Then he quotes Pleville le Peley, and remarks: "This theory associates the mackerel with many other sedentary fishes which pass the winter at the bottom of the sea, stupefied by the cold into a kind of lethargy, and would seem to explain why in October young mackerel of ten and fifteen millimetres are taken, why in winter others of larger size are taken, not with a line, but with nets which entangle those which have not already buried themselves in the mud or the sand."* Another quotation is made† from Shaw's "General Zoology or Systematic Natural History," published 1803. Hind asserts "that the four disputed points in relation to the natural history of this fish are there asserted, namely, its local habits, its torpidity during hybernation, the film over the eye, and the fact of its being partly embedded in the soft mud or sand during its winter sleep."

I admit that Shaw asserts the presence of a film over the eye. He does not, however, even give the theory of hybernation his personal indorsement, but, remarking that the long migration of the mackerel and herring seems at present to be called in question, continues: "It is thought more

* Nouveau Dictionnaire General des Peches, etc, Par H. de la Blanchere; Paris, 1868, p. 183.
† Hind, op. cit Part II., p. 10.

probable that the schools which appear in such abundance round the more temperate European coasts in reality reside during the winter at no very great distance, immersing themselves in the soft bottom, and remaining in a state of torpidity from which they are awakened by the warmth of the returning spring and gradually recover their former activity." Even if Shaw could fairly be quoted as a supporter of this theory, his opinion is of little value. He was not a naturalist, but a book-maker, and his compilations are acknowledged to be inaccurate.*

The opinions of Dr. Bernard Gilpin and the late Rev. John Ambrose, two excellent Nova Scotian observers, are quoted,† though with no apparent reason, for the latter remarks only that "it is the opinion of some" that the third run of mackerel, which come to St. Margaret's Bay about the first of August, are not returning from the Gulf of St. Lawrence, but from the sea, and "it may be that a portion of the immense school, passing eastwardly in the spring, strikes off to some favorite bank outside to deposit the spawn. Or there may be a sort that never go as far east or west as the others, but winter along our shores," etc., etc, while Dr. Gilpin expressly remarks that though the *asserted torpidity and blindness* favor the idea of hybernation, he does not think that we have yet sufficient proof to assert them as facts.

The authorities brought forward in support of the hybernation theory do not, in fact, support it, and the testimony cited by Prof. Hind is merely tradition and popular opinion, some obtained directly, the remainder at second-hand.

* See a criticism on Shaw's General Zoology in Gills Arrangement of the Families of Fishes etc., 1872, pp. 40 and 41.

† Part I., p. 79.

(3.) Still another set of arguments is based upon the supposed hybernating habits of other species of fishes. Prof. Hind remarks: "In seas which are not ice-incumbered the winter torpidity of the mackerel may be of very short duration; in ice-incumbered seas it may extend over several months. In this particular this mackerel resembles the sturgeon of the Caspian Sea, whose torpidity during the winter is well known, and this winter sleep is not confined to these fish, but is probably much more general than is usually supposed."* Here we have a definite statement. The mackerel hybernate, and the winter sleep is not confined to the mackerel.

The only hybernation which is definitely know to occur among fishes takes place in the fresh-water lakes and streams of cold regions. The fish are driven by cold into the deeper waters, and there remain in a state of torpor proportionate in degree to the amount of cold which they experience. They may even be frozen up in the midst of a mass of ice and recover their vitality when the ice is melted. Mr. Milner had a mud-minnow (*Umbra limi*) which was frozen in solid ice in the middle of an aquarium globe three or four times, and each time recovered its vitality upon thawing out. Marine in the extreme north doubtless undergo similar experiences, fishes though I am not aware that any record of such a phenomenon has ever been published.

In warm regions an analogous phenomenon takes place, which has been called æstivation. When the lakes and streams are dried up by the heat, the fish seek refuge in the deepest pools, and when these too are dried, they bury themselves in the mud at the bottom and remain torpid until the rainy season refills the reservoirs and revives them. Hybernation and æstivation do not appear in any case voluntary acts. The fish

* Part II., p. 11.

do not become torpid of their own volition. They avoid it as long as they can, and only succumb when they are deprived of means of escape. They never become torpid when there are greater depths to which they can retreat.

(4.) Professor Hind lays much stress upon the presence of a "film" over the eyes of the spring and the autumn mackerel and upon their alleged capture in winter in the waters of the Dominion, and also quotes arguments for hybernation, based upon the resemblance of the mackerel to the batrachians (which are known to be capable of hybernation) in color, and upon its resemblance to embryonic forms of other fishes, which is supposed to "prove him low in the scale of intelligence."* To the latter it is needless to refer. The so-called "film" on the eye is not peculiar to the mackerel. Many fishes, such as the shad, the alewife, the menhaden, the bluefish, the mullet, the lake white-fishes, and various cyprinoid fishes, have a thick, tough membrance covering the anterior and posterior angles of the orbits, narrowing the opening to the form of an ellipse, with a vertical major axis. This possibly becomes somewhat more opaque in seasons of decreased activity. It has never been observed to cover the whole eye. Until the fact has been established that "a skin forms over the eye" in winter, it is quite unnecessary to propose the theory that such a skin "is probably designed to protect that organ from the attacks of the numerous parasitical crustaceans and leaders which infest the external portions of the bodies of fishes, and are also found internally, as in the gills of codfish."†

* Part I., p. 79.

† Hind, op. cit., Part II., p. 11.

III. CRITICISM OF THE ARGUMENT BASED UPON THE PRESENCE OF MACKEREL IN NORTHERN WATERS LATE IN THE SEASON.

A number of instances are cited to prove that the mackerel schools remain on the Dominion coast throughout the winter season. If this can be well established it is a very strong argument in favor of hybernation. Let us analyze this testimony.

Dr. Gilpin is quoted to the effect that, during some seasons, they linger on the Nova Scotian coast until December, and allusion is made to a mackerel obtained by him at Halifax, Oct. 27, 1875.* Mr. John Rice remembers that his father used often to speak of mackerel "coming on shore like squid, with scales on their eyes, and blind, about Christmas," about forty years ago.† Mr. Jabez Tilley states that they have been taken in November in Trinity Bay. Prof. Hind also states that they are to be found on the whole coast from Quirpon to Cape Spear during November and December. He gives no authority for this statement, and it is to be inferred that it is founded upon personal observation. Then there is the vague statement of Mr. Ambrose, already quoted, that mackerel have been speared on muddy bottoms under the ice.

Now this testimony does not, by any means, tend to prove that the mackerel remain near the coast in winter. In the first place, there is no satisfactory proof of their occurrence later than Oct. 25, since that is the only evidence fortified by a memorandum of date, and the memories of fishermen are not more certain than those of other men. In the second place, it is not impossible that mackerel linger in these waters until November, or even December, in the case of a warm autumn. The temperature necessary for the menhaden

* Part I., p. 79.

† Part I., p. 78.

cannot be many degrees below 50 deg., while the mackerel appears to endure a temperature of 40 deg. or less. Menhaden linger in Maine waters till November, and in Massachusetts Bay and the Vineyard Sound till December.

Finally, the undoubted capture of many individuals in winter on the coast of Newfoundland would, by no means, prove that the great schools were there throughout the season. Disabled, blind, or diseased individuals would naturally be unable to accompany the departing school. Such fish would naturally grovel on the bottom in a helpless state, and might easily become impaled on the eel-spears, or might occasionally be accidentally detained. Mr. Peter Sinclair, a well-known fisherman of Gloucester, stated to Prof. Baird that, some years ago, a school of mackerel were detained all winter in a small river in Nova Scotia and were speared out of the mud. This is, doubtless, hearsay testimony, and is given for what it is worth. I do not doubt that there have been individual cases of this kind, but I maintain that no generalization should be founded upon them.

IV. THE MOVEMENTS OF FISHES ON THE COAST OF THE UNITED STATES.

The preceding paragraph is devoted to the refutation of the idea that sea-fish hybernate. This is regarded as the least probable of the three hypotheses stated. On page 28, it is stated that the sea-herring and many other fishes have two kinds of migrations, one bathic, or from and toward the surface, the other littoral, or coastwise. Now in some species the former is most extended, in others the latter. The anadromous species very probably strike directly out to sea without coasting to any degree, while others, of which the mackerel is a fair type, undoubtedly make extensive coastwise

migrations, though their bathic migrations may without any inconsistency be quite as good as those of the species which range less. Upon this point I cannot do better than to quote a manuscript from letter written by Professor Baird to the Hon. Hamilton Fish, Secretary of State, dated July 21, 1873. Having expressed the views concerning the migration of the herring and shad, already quoted, continues:

"The fish of the mackerel family form an exception to this rule. While the herring and shad generally swim low in the water, their presence being seldom indicated at the surface; the mackerel swim near the surface, sometimes far out to sea, and their movements can be readily followed. The North American species consists of fish which as certainly, for the most part at least, have a migration along our coast northward in spring and south in autumn, as that of the ordinary pleasure seeker, and their habit of schooling on the surface of the water enables us to determine this fact with great precision. * * * Whatever may be the theories of others on this subject, the American mackerel fisherman knows perfectly well that in the spring he will find the school of mackerel off Cape Henry, and that he can follow them northward day by day as they move in countless myriads on to the coast of Maine and Nova Scotia."

V. A CRITICISM OF CERTAIN RECENT THEORIES.

It is difficult to estimate to what extent the advocates of the hybernation theory have been influenced by patriotic motives in their efforts to prove that the mackerel remain in the waters of the Dominion of Canada throughout the entire year. It is certain that all recent treatises on ichthyology by Canadian writers have appeared in the form of campaign

documents, apparently intended to influence the decisions of Diplomatic Commissions.

I am by no means prepared to maintain that mackerel do not pass the winter in the American domain of her Imperial Majesty. It seems important, however, that the subject of the migration of fishes should be restored to its proper position as a question of abstract scientific interest. Let us glance at the argument of Mr. Whitcher and Professor Hind against what the former is pleased to style the "American Theory."

In the report of the Minister of Marine and Fisheries for the year ending the 30th of June, 1871, Mr. W. F. Whitcher, Commissioner of Fisheries, published a paper entitled, "American Theory Regarding the Migration of the Mackerel Refuted" (pp. 186–189).

Mr. Whitcher opens his letter by claiming that the theory of north and south migration was invented solely in support of a claim advanced by citizens of the United States to participate in the Canadian inshore fisheries. "This ingenious but traditional theory of annual migration having gained local credency among some of the Nova Scotia fishermen engaged in United States fishing-vessels, has been sagaciously indorsed and circulated by American authors." He also refers to evidence "supposed to have been procured among the fishing population of the New England States."

I need only say that these claims are unjust, and that the theory of the annual north and south migration of the mackerel is time-honored, and was held conscientiously by ichthyologists of the United States and the Provinces long before the question of fishery treaties assumed its present aspect. It is manifestly unfair to state that while the theories which prevailed respecting the habits of herring and mackerel were

formerly similar that, "in the former case it is probable that traditionary and imperfect information formed the basis of error, while in the latter instance it is most probably founded on misinformation dictated by sectional interests." Mr. Whitcher's own paper upon migration is the only one of American origin in which I have seen scientific method sacrificed to partisan spirit.

Having read Mr. Whitcher's introduction, one might readily predict what sort of an argument he will wrench out of the statements of "such disinterested authorities as may be readily quoted." First he gives extracts from Mitchell and the Edinburgh Encyclopædia regarding the habits of the herring. Granting all that is claimed about the herring, without reference to the reliability of these authorities, what do we find? Merely a begging of the question! The habits of the herring and mackerel are not known to be the same. In many particulars they are diametrically different, for the former loves cold water, the latter warm water.

Various provincial writers are now quoted: Mr. Perley, who says that "naturalists now tell us," and "it is now considered settled," that the mackerel is not migratory, but draws off into deep water at the approach of winter; and Mr. Knight and Mr. Fortin—though the reason for these quotations is not apparent, since no reference to the winter habits of the fish can be found therein. He does not refer to the writings of Mr. Ambrose and Johnston, Canadian writers, who advocate the migration theory. Yarrell and Couch are next quoted, though neither of them ventures to give a decided opinion. Finally, we have a paragraph compiled from five French Encyclopædias, good and bad, no means being afforded of distinguishing the opinions of Cuvier from those of Chenu's literary staff. Mr. Whitcher's conclusion is this, "that it is

clearly neither necessary nor accurate that mackerel should perform the migrations ascribed to them by American writers." The migrations of the mackerel are neither proved nor disproved by special pleadings of this description.

The spirit of Prof. Hind's publication is very different. He writes from the standpoint of an investigator, and his book is an important contribution to our knowledge of the habits of fishes in relation to temperature and currents. I feel obliged, however, to call attention to a very serious flaw in his chief argument against the annual migration of the mackerel. In the chapter on the "Relation of the Supposed Migratory Movements of Mackerel to Isothermal Line"* it is claimed that a migration to the north in the spring "presupposes the movements of bodies of the same great schools of mackerel" which are alleged to pass Massachusetts Bay from the waters of the coast of Virginia and New Jersey, not only through from ten to twelve degrees of latitude, but it assumes that they are able to cross in the early summer, and frequently before spawning, numerous isothermal lines in descending order. He then refers to the article upon the Gulf Stream in Petermann's Mittheilungen for 1870, in which the marine isothermals for the different months are shown by means of a chart. A table is given showing the isothermals for July. That of 68 degs. would touch the coast at Delaware Bay; that of 63 degs. 5 mins. at Long Island; that of 59 degs. at Boston; that of 54 degs. 5 mins. at Cape Sable, N. S.; that of 50 degs. at Cape Race, and that of 45 degs. 5 mins. at the Straits of Belle Isle.

From this he concludes that "a school of fish moving rapidly from Delaware Bay to the Straits of Belle Isle, would pass in July from a mean temperature of 68 degs. to a

* Hind, op. cit., Part II., pp. 13-17.

mean temperature of 45 degs., a difference of more than 22 degs. Fahrenheit."

This theory would be very satisfactory if it could be admitted that the isothermals for July indicate the actual temperature of the sea from day to day. In reality the marine isothermals are constantly varying, and in this respect are different from those printed upon a chart, as no one knows better than Professor Hind. A glance at the tables appended, and the conclusions deduced from them in regard to the menhaden, will show that schools of fish do not find it necessary to force their way through walls of sea temperatures, but that their movements from south to north are exactly correlated with the seasonal rise of temperatures. As soon as the water at a given point reaches a certain temperature, which for the mackerel on our own coast appears to be as much as 45 degs., the fish make their appearance, and with the advance of the season they appear further and further to the north. Mackerel do not appear on the coast of Maine until the water there is as warm as it was off Cape Hatteras at the time of their first arrival. This is the case whether we suppose their general movement to be parallel with or vertical to the coast line.

I have entered the discussion of this question, not with any idea of attempting to prove that mackerel migrate south from the Gulf of St. Lawrence, but to show that a comparatively rapid northward movement in May and June does not necessitate a "sudden plunging from high to low zones of temperature."

VI. THE ARGUMENTS FOR AND AGAINST EQUATORIAL MIGRATION.

There is no satisfactory evidence that the menhaden pursue extended migrations north and south. The same evidence

which tends to show that the shad, salmon, and alewife do not follow this course, will apply, with modifications, to the menhaden. The menhaden schools at different points along the coast appear to have individual peculiarities corresponding to those of the shad in the different rivers. A Maine menhaden may be easily distinguished from the Long Island menhaden, a Chesapeake or a Florida one by certain differential characters easy to perceive, but difficult to describe. The presence of the crustacean parasite in the mouths of the Southern menhaden, and its absence from those of the North, is a very strong argument in favor of local limitation in the range of menhaden schools. That the same school of menhaden return year after year to the same feeding-ground is rendered very probable by the statements elsewhere given in detail. The schools in the Southern waters do not receive any apparent increment at the time of desertion of the north coast, nor are the southern waters deserted at the time of abundance in the North. There is, however, a limited north and south migration. The Maine schools, on their departure in the fall, appear to follow the southward trend of the coast until they strike the hook of Cape Cod, where they are detained for some days; they then round the Cape and are again detained by the hook of Montauk Point. They first strike the shore at Point Judith, and are turned over into Peconic Bay by the line of islands stretching across the eastern end of Long Island Sound. In the same way the Chesapeake schools are said to be detained for some days by the projection of Cape Henry.

VII. THE ARGUMENTS FOR AND AGAINST THE THEORY OF SOJOURN IN THE WARMER STRATA OF MID-OCEAN.

The questions of hybernation and extended migration having been considered, it only remains to discuss the third

PLATE I.—From Report of Capt. Sir G. S. Nares, R. N.

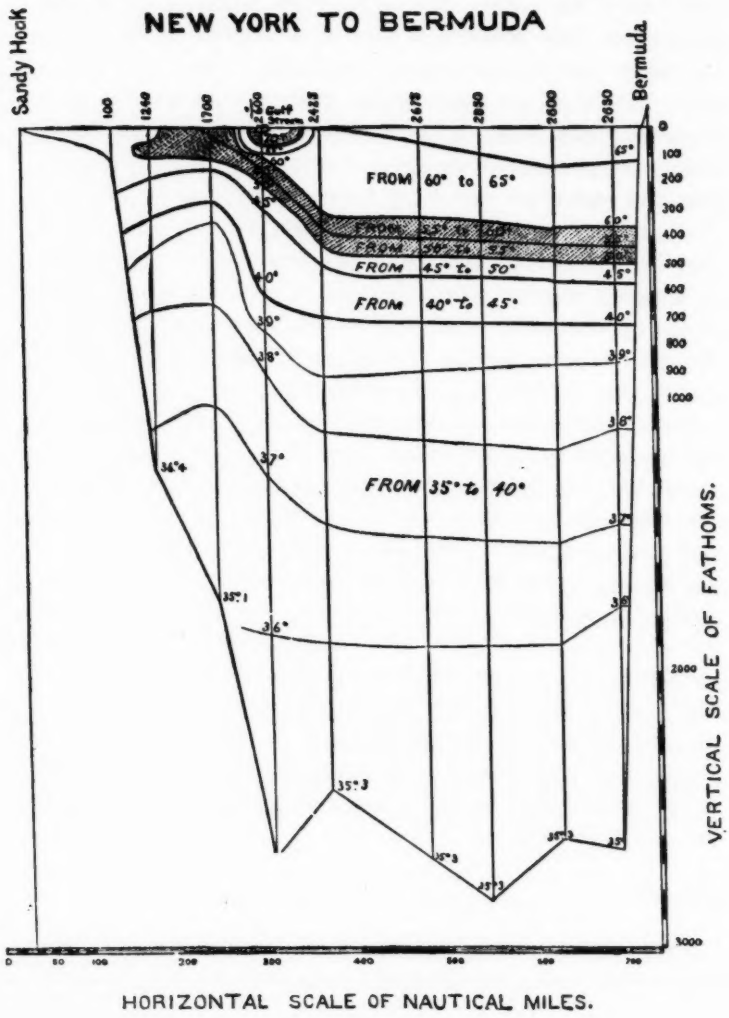
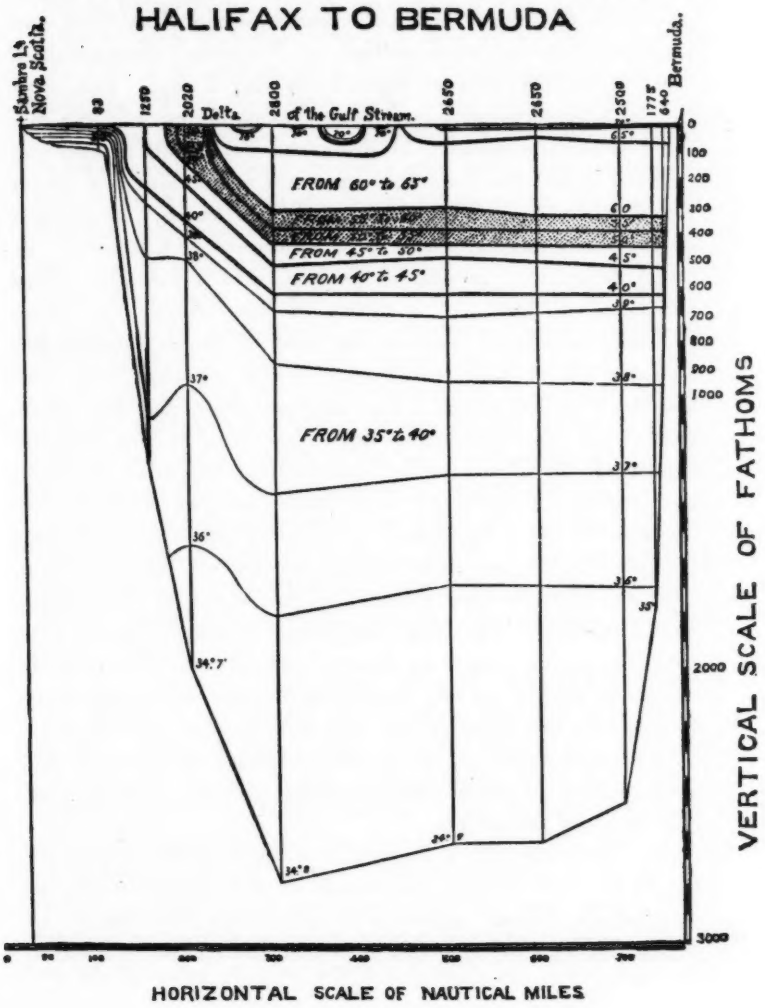


PLATE II.—From Report of Capt. Sir G. S. Nares, R. N.



alternative—that of the possibility of sojourn in the warm strata of the open ocean. In plate I. is given a diagram section of the North Atlantic Ocean between New York and Bermuda, showing the soundings and isothermal lines obtained in H. M. S. "Challenger," April 24 to May 8, 1873. The vertical scale is necessarily enormously exaggerated, but the diagram shows the presence of strata under the Gulf Stream and between it and the American coast, the temperature of which exactly meets the requirements of the menhaden. At a depth of 50 to 100 fathoms there is a shoreward extension of the warm stratum of 50 deg. to 55 deg., which extends inward 120 miles. There are no means of determining the corresponding isothermal lines on the coast of North Carolina, but an extension of much less degree would approach very near the shore in that region. The diagram represents the condition of the sea temperatures near New York at the very period when the menhaden are approaching the coast in April, and a similar relation not improbable exists in November at the time of their departure. The schools of fish, swimming out to sea when the shore waters become too cold for them, and driven below the surface by the winds of November, would naturally strike these temperate strata, and being kept from descending deeper by the uniform coldness of the waters below, as well as by the increasing pressure, and their efforts to approach the shore being also opposed by a temperature barrier, they would remain in the temperate strata until they were enabled by the warmth of spring to regain their feeding-grounds near the shores.

No authorities can be quoted in support of this hypothesis, but in the case of the menhaden, at least, it appears to explain more of the difficult questions in relation to periodical movements than that of hybernation or that of extended migration,

(1) It presupposes less sudden changes of temperature than that of hybernation. It has been shown that hybernation of fishes is never voluntary, but is a state of torpidity, induced, like that of æstivation, by a change of temperatures and surroundings, which they have no power to avoid. Before entering upon hybernation or æstivation, fishes retreat to the deepest water, and only become torpid when they are followed thither by the changed conditions of existence. In the fresh water of temperate countries fishes do not become entirely torpid in cold weater, but are sufficiently active, to be taken with hooks from under the ice. This is also the case in sub-polar regions. The kalleraglitz, or American turbot (*Reinhardtius hippoglossoides*), is taken with hooks in the dead of winter under the floe-ice of North Greenland at a depth of 300 fathoms, in South Greenland, on the oceanic banks, at 60 and and 80 fathoms, and at Fortune Bay, Newfoundland, it is captured in the shore herring-seines at the same season.

So long as the menhaden can avoid the extremes of temperature, which they so carefully avoid in summer by seeking congenial warmth in the ocean strata under the Gulf Stream, need we suppose that they will plunge into the colder strata below?

(2.) It involves less radical changes than hybernation in the habits of the fishes. Some fishes, like the mud-minnow (*Umbra limi*) of the eastern United States, are peculiarly adapted for a life in the mud. Others, such as the "compound breathers" (*Labrynthici*) of India, are said to respire with ease with their head covered by liquid mud. Such fishes, however, are totally different in organization from the free swimming species of the open seas. All free swimmers are especially heedful to avoid contact with the bottom. This is so in the case of the herring family, of which the men-

haden is a member. They are provided usually with deciduous scales, and never suffer themselves to come in contact with the bottom. If one of the herring or mackerel tribe is placed in an aquarium it will be noticed that it keeps itself always free from the bottom. Other fishes in the same tank, such as the sea-bass, tautog, or king-fish, will be seen to rest on the bottom, and even to take refuge under the stones. It is extremely improbable that mackerel ever sink into the mud of the ocean bottom—still more so in the case of the menhaden.

(3.) It accounts better than the other theories for the early appearance of the fish in the spring. Admitting a possibility of a winter's sojourn in the mud, we are met by a difficulty when we try to account for the prompt appearance of the fishes in the spring. The deeper strata of the ocean are now known to preserve throughout the year the uniform temperature of 28.4 to 35 deg. The fish, once mummified in the depths of the ocean, would remain so for ever unless they are admitted to possess powers unknown to exist in other animals.

On the other hand, if we suppose the fish to be swimming in the strata of mid-ocean, we know that they are just in the position to be susceptible to all the daily variations of temperature. Following with the advance of the season the inward curving of the Gulf Stream, the warm strata below it gradually approaches the shore. The schools of fish are thus enabled gradually to draw nearer to the coast line, and when the strata of 50 deg. to 55 deg. in temperature touch the coast the menhaden are at hand.

(4.) It explains as well as the hybernation theory, and better than the migration theory, the peculiarity of the different schools at different localities along the coast. This was discussed on page 51.

(5.) It explains better than the other theories the appearance of the fish at the time of their arrival in the spring. The menhaden appear to be bottom-feeders. If they migrated coastwise to the south they would find these feeding-grounds. If they sank to the bottom they would find food, if they had sufficient vitality to resurrect themselves in the spring. If they passed the winter in the mid-ocean strata they could obtain no food, and would naturally become emaciated, the accumulated fat of the preceding summer being absorbed.

IV. A NEW CLASSIFICATION OF THE HABITS OF THE MARINE FISHES.

Rimbaud's classification, which is a modification of one recognized in the markets of South France, is very suggestive, but it does not appear to me to be entirely applicable to the fishes of our coast, at least not in the way in which it has been usually adopted.

Rimbaud makes four divisions, viz.:

I.—Wandering fishes (*Poisson nomade*).

II.—White fishes (*Poisson blanc*).

III.—Bottom fishes (*Poisson de roche*, or *Poisson de fond*).

IV.—Alien, or outside fishes (*Poisson forain*).

The distinction between classes I. and IV. does not appear to be very clearly marked. In the Western Atlantic some of the fishes making up class IV. belong to each of the other classes.

A more natural classification would be its three divisions, which might readily be co-related with the three kinds of migration mentioned in the preceding paragraph.

The first group would include the wandering fishes, the *Poisson nomade* of Rimbaud, whose migrations are entirely

oceanic, and confined to the surface zone. The second group would include the bottom fishes of restricted range, the *Poisson de fond* of Rimbaud, which move to and from the shore or the shallows, and which do not range.

The third group would include the middle classes, those which take advantage of both methods of migration, and corresponds approximately to Rimbaud's second division. "White fishes" seem hardly an appropriate name. Coast-fishes would probably be more expressive.

Col. Lyman in his report "On the Limits of Artificial Culture, and the Possible Exhaustion of Sea Fishes," * speaks of the first class as the wandering or "schooling" fish of the high seas. The term schooling is liable to mislead, for the "white fishes" also school. Among the wandering fishes he mentioned only "the herring (*Clupea elongata*), mackerel (*Scomber vernalis*), menhaden (*Alosa menhaden*), cod (*Gadus morrhua*), etc." The cod and herring most certainly are "white fishes," and the menhaden and mackerel are certainly not to be ranked with "those which appear on the coast only when 'migrating,' and then in vast but uncertain troops," (p. 63.)

A provisional classification by habits of the fishes of our eastern coast might stand somewhat as follows:

(1.) *Wandering, or Surface Fishes.*—These remain in our waters only for a short time, their movements being capricious or accidentally directed by the ocean currents, or else in search of food. They do not spawn on our coast, and their young are never seen in our waters. The best known examples are the sword-fish (*Xiphias gladius*), the spear-fish (*Tetrapturus albidus*), the bonito (*Pelamys sarda*), the tunny (*Orcynus thynnus*), the dwarf tunny (*Orcynus alliteratus*), the ceroes and

* Report of the Commissioners of Fisheries for Massachusetts for the year ending January 1, 1870. pp. 58-67.

Spanish mackerel (*Cybium maculatum*, *C. caballa* and *C. regale*), the rudder-fishes (*Halatractus zonatus*, *Naucrates ductor*), and (*Palinurichthys perciformis*), the dolphin (*Coryphæna*, two or three species), the remoras (*Echeneididæ*), the barracuda (*Sphyræna borealis*), the lady-fish (*Albula vulpes*), the tarpum (*Megalops thrissoides*), the oceanic sharks, such as *Galeocerdo tigrinus*, and the numerous waifs from the West India fauna. Of these only the sword-fish, bonito, and the ceroes and Spanish mackerel, are, at present, of economic importance.

(2.) *Local, or Bottom Fishes.*—These remain in our waters throughout the year, their movements being chiefly to and from the shore, though many of their species move for long distances up and down the coast. They prefer a somewhat uniform temperature, which they secure by going into the shallows in the summer and depths in the winter in the northern districts of their distribution, while in the southern districts of distribution their movements are reversed. They spawn on our coast, usually in shallow water and during their shoreward sojourn. The principal representatives of this group are the goose-fish (*Lophius piscatorius*), the flounder, and flat-fishes, the halibut (*Hippoglossus vulgaris*), of whose spawning habits little, however, is known; the lump-fish (*Cyclopterus lumpus*), and the two species of *Liparis*, the cod (*Gadus morrhua*), haddock (*Melanogrammus æglefinus*), pollock (*Pollachius carbonarius*), and the hakes (*Phycis chuss* and *P. americanus*), the gumards and sculpins (*Prionotus sp.* and *Cottus sp.*), the rose-fishes (*Sebastes sp.*), the tautog (*Tautoga onitis*), and the chogest (*Tautogolabrus adspersus*), the skates, the rays, and the ground sharks.

(3.)—*The Coast or Ranging Fishes.*—These are in our coast waters for a portion of the year, and when absent from them are supposed to retreat to the depths of the ocean. When

near the shores their movements are a combination of those of the two previous classes, and they wander widely up and down the coast. They spawn upon our continental slope, some entering the rivers, some upon the in-shore shallows, and some upon the off-shore shoals, their young coming to the shores with their parents. They all are summer visitors in the northern districts of their distribution, though some, like the herring, only appear in New England in the winter. The best known examples of this group are among the river-spawning, or anadromous species, the salmon (*Salmo salar*), the shad (*Alosa sapidissima*), the alewife (*Pomolobus pseudoharengus*), and perhaps the striped-bass (*Roccus lineatus*), and the smelt (*Osmerus mordax*). Among the shore-spawning species in the North, the capelin (*Mallotus villotus*), the launce (*Ammodytes lanceolatus*), and the herring (*Clupea harengus*): In the South the scuppaug (*Stenotomus argyrops*), sheepshead (*Archosargus probatocephalus*), the sea-bass (*Centropistes atrarius*), the atherine (*Chirostoma notatum*), the mullet (*Mugil sp.*), and the mackerel (*Scomber scombrus*); and among the off-shore spawners, the pompano (*Trachynotus carolinus*), the squeateague (*Cynoscion carolinensis*), and the menhaden (*Brevoortia tyrannus*), and probably the blue-fish (*Pomatomus saltatrix*).

TABLE I.

TABLE OF SURFACE TEMPERATURES—March, 1876, to February, 1877, inclusive, at 3 P. M.

PLACE OF OBSERVATION.	SPRING.			*Quarter ending May 31, 1876.*	SUMMER.			*Quarter ending Aug. 31, 1876.*	AUTUMN.			*Quarter ending Nov. 30, 1876.*	WINTER.			*Quarter ending Feb. 28, 1877.*	*Year ending Feb. 28, 1877.*
	MARCH.	APRIL.	MAY.		JUNE.	JULY.	AUGUST.		SEPTEMBER.	OCTOBER.	NOVEMBER.		DECEMBER.	JANUARY.	FEBRUARY.		
Eastport, Maine,	32.5	35.3	38.4	35.4	42.7	47.2	50.2	46.7	50.6	50.	46.1	48.9	40.1	31.5	29.8	33.8	41.02
Portland, Maine,	33.9	38.1	47.3	39.7	56.9	66.7	63.9	62.5	57.1	50.3	44.9	50.7	34.5	30.6	33.9	33.	46.4
Woods Holl, Mass.	34.3	43.2	52.3	43.2	67.4	75.1	72.4	71.6	....	56.4	48.	52.2	34.3	29.9	31.4	31.8	49.5
New London, Conn.	38.	46.1	56.8	46.9	69.2	73.	73.3	71.8	65.5	57.2	49.7	57.7	38.2	33.8	36.2	36.	52.6
New York, N. Y.	33.5	39.6	51.	41.3	68.1	72.2	72.5	70.9	64.5	53.	47.	54.8	32.3	28.2	32.4	30.9	49.4
Baltimore, Md.	42.	51.5	64.5	52.6	77.1	84.1	78.3	79.8	70.7	58.	50.8	59.8	35.	32.2	....	33.6	56.4
Norfolk, Va.	48.8	57.6	67.9	58.	79.6	84.4	78.1	80.7	69.2	60.5	53.8	61.1	36.8	38.6	44.	39.8	59.9
Kitty Hawk, N. C.	....	....	....	....	72.8	78.1	78.5	74.8	72.4	....	....	...	....	....	....	....	....
Wilmington, N. C.	55.3	61.9	71.7	62.9	75.3	81.3	80.3	78.9	77.3	64.1	58.2	66.5	44.5	41.9	50.1	45.5	63.4
Charleston, S. C.	59.1	64.3	72.8	65.4	79.4	85.3	85.6	83.4	81.1	64.5	60.8	68.8	46.6	48.3	52.2	49.	66.6
Savannah, Ga.	56.5	60.5	67.2	61.4	72.	77.6	83.	77.5	81.3	....	53.6	67.4	44.4	48.9	51.7	48.	63.8
Jacksonville, Fla.	64.8	73.1	80.9	72.9	85.2	88.3	83.2	87.2	86.1	72.6	67.3	75.3	51.2	56.6	58.9	55.5	72.7
Key West, Fla.	75.4	78.5	83.1	79.	86.6	86.4	86.4	86.4	87.7	81.5	74.2	81.1	66.4	73.1	69.3	69.6	79.

TABLE III.

Table of Mean Temperatures of Surface and Bottom—March, 1876, to February, 1877, inclusive.

PLACE OF OBSERVATION.	SPRING.			*Quarter ending May 31, 1876.*	SUMMER.			*Quarter ending Aug. 31, 1876.*	AUTUMN.			*Quarter ending Nov. 30, 1876.*	WINTER.			*Quarter ending Feb. 28, 1877.*	*Year ending Feb. 28, 1877.*
	MARCH.	APRIL.	MAY.		JUNE.	JULY.	AUGUST.		SEPTEMBER.	OCTOBER.	NOVEMBER.		DECEMBER.	JANUARY.	FEBRUARY.		
Eastport, Maine,	32.3	35.1	38.1	35.1	41.7	46.5	49.6	46.1	50.3	49.9	46.	48.7	39.5	31.2	29.5	33.4	40.8
Portland, Maine,	33.6	37.5	45.6	38.9	55.4	63.	62.1	60.2	56.2	49.5	44.6	50.	34.7	30.5	33.4	32.9	45.5
Woods Holl, Mass,	33.9	43.	51.9	42.9	66.4	74.6	72.	71.	...	56.3	47.8	54.4	33.7	29.5	31.3	31.5	49.9
New London, Conn.	37.5	44.4	53.7	45.1	65.2	70.8	73.7	69.9	65.4	57.2	50.1	57.7	38.6	33.9	35.5	35.9	52.1
New York, N. Y.	33.1	39.4	50.6	41.	67.4	71.5	72.2	70.4	64.4	52.7	46.5	54.5	32.3	28.1	32.2	30.8	49.1
Baltimore, Md.	41.6	50.8	63.9	51.7	76.9	83.6	75.2	78.5	70.6	57.9	50.6	59.6	34.9	32.1	....	33.3	55.7
Norfolk, Va.	48.5	57.2	67.6	57.7	79.1	82.3	77.7	79.7	67.6	60.1	53.6	60.4	36.6	38.1	43.4	39.3	59.2
Kitty Hawk, N. C.	....	....	....	....	....	....	....	....	..	....	.. .	....	....	...	....	....	....
Wilmington, N. C.	55.1	61.8	71.5	66.1	75.1	81.2	80.2	78.8	77.2	65.2	57.6	66.7	43.8	42.4	49.3	45.1	64.1
Charleston, S. C.	58.5	64.1	72.6	65.	79.9	85.1	84.9	83.3	81.	65.7	60.8	64.2	46.6	48.2	52.2	49.	65.3
Savannah, Ga.	56.3	60.1	67.	61.1	71.8	77.2	82.8	77.2	81.	...	53.3	....	44.2	48.4	51.5	47.8	....
Jacksonville, Fla.	64.7	73.3	80.9	77.8	85.	88.3	87.5	87.	85.9	72.6	67.7	75.5	51.	56.5	58.8	55.5	73.9
Key West, Fla.	75.2	78.7	82.7	77.5	86.1	86.2	85.9	86.	87.3	81.2	73.9	80.8	66.3	72.8	68.9	69.3	78 4

TABLE II.

TABLE OF BOTTOM TEMPERATURES—March, 1876, to February, 1877, inclusive, at 3 P M.

PLACE OF OBSERVATION.	SPRING.			Quarter ending May 3, 1876.	SUMMER.			Quarter ending Aug. 3, 1876.	AUTUMN.			Quarter ending Nov. 3, 1876.	WINTER.			Quarter ending Feb. 28, 1877.	Year ending Feb. 28, 1877.
	MARCH.	APRIL.	MAY.		JUNE.	JULY.	AUGUST.		SEPTEMBER.	OCTOBER.	NOVEMBER.		DECEMBER.	JANUARY.	FEBRUARY.		
Eastport, Maine,	32.1	34.9	37.9	34.9	41.7	45 8	49.	45.5	50.1	49.8	45.9	48.6	39.	31.	29.2	33.	40.5
Portland, Maine,	33.3	37.	44.	38.1	54.	59.4	60.4	57.9	55.3	48.8	44.3	49.4	35.	30.5	33.	32.8	44.5
Woods Holl, Mass.	33.5	42.9	51.5	42.6	65.5	74.2	71.6	70.4	66.3	56 2	47.6	56.7	33.1	29.2	31.3	31.2	50.2
New London, Conn.	37.	42.7	50.6	43.4	61.3	68.7	74.2	68.	65.3	57.3	50.6	57.7	39.	34.	34.9	35.9	52.2
New York, N. Y.	32.8	39.2	50.2	40.7	66.8	70.9	72.	69.9	64.3	52.4	46.1	54.2	32.4	28.1	32.1	30.8	48.9
Baltimore, Md.	41.3	50.7	63.4	51.8	76.8	83.2	72.1	77.8	70.5	57.8	50.4	59.5	34.9	32.1	....	33.	....
Norfolk, Va.	48.2	56.9	67.4	57.5	78.7	80.3	77.3	78.7	66.1	59.8	53.4	59.7	36.4	37.6	42.9	38.9	58.7
Kitty Hawk, N. C.	....	....	....	....	....	....	....	....	....	....	....	...	....	....	....	...	....
Wilmington, N. C.	55.	61.7	71.3	69.3	75.	81.1	80.2	78.7	77.2	66.4	57.1	66.9	43.1	43.	48.5	44.8	64.9
Charleston, S. C.	58	63.9	72.5	64.7	80.4	85.	84.2	83.2	81.	67.	60.9	69.6	46.7	48.2	52.2	49.	66.6
Savannah, Ga.	56.2	59.8	66 8	60.9	71.7	76.8	82.7	77.	80.7	....	53.	....	43.8	47.9	51.3	47.6	....
Jacksonville, Fla.	64.7	73.6	80.9	72.7	84.9	88.3	87.2	86.8	85.8	72 5	68.2	75.5	51.3	56.5	58.7	55.5	72.6
Key West, Fla.	75.	79.	82.3	76.	85.6	86.	85.5	85.7	87.	81.	73.6	80.5	66.2	72.5	68.6	69.1	77.8

TABLE IV.

Table of Mean Temperatures of Surface and Bottom—March, 1877, to February, 28, 1878, inclusive.

PLACE OF OBSERVATION.	SPRING.			*Quarter ending May 31, 1877.*	SUMMER.			*Quarter ending Aug. 31, 1877.*	AUTUMN.			*Quarter ending Nov. 30, 1877.*	WINTER.			*Quarter ending Feb. 28, 1878.*	*Year ending Feb. 28, 1878.*
	MARCH.	APRIL.	MAY.		JUNE.	JULY.	AUGUST.		SEPTEMBER.	OCTOBER.	NOVEMBER.		DECEMBER.	JANUARY.	FEBRUARY.		
Eastport, Maine,	....	32.4	....	....	39.4	43.	46.1	42.8	48.7	47.4	45.8	47.3	41.8	36.8	....	....	....
Portland, Maine,	....	41.5	....	....	54.1	57.2	61.	57.6	58.7	51.9	45.3	51.9	40.2	33.5	....	....	....
Woods Holl, Mass.	....	43.	....	....	63.9	68.3	70.9	67.7	68.8	....	49.7	....	42.	....	....	....	....
New London, Conn.	....	44.6	....	....	62.2	67.5	71.	66.9	67.2	59.7	49.9	58.9	43.5	37.5	....	....	....
New York, N. Y.	....	41.6	....	....	62.6	....	73.	....	67.6	59.	47.3	57.9	39.3	33.8	....	....	....
Baltimore, Md.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Norfolk, Va.	....	56.1	....	....	73.3	79.4	79.	77.2	70.3	62.	53.9	62.	43.	25.	...	....	....
Kitty Hawk, N. C.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Wilmington, N. C.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Charleston, S. C.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Savannah, Ga.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Jacksonville, Fla.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Key West, Fla.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....

The Secretary presented a telegram from Messrs. Wilmot and Whitcher, Fish Commissioners of Canada, expressing their regret at being unable to be present, as a freshet was just then endangering their hatching-houses.

J. CARSON BREVOORT, in response to a call of the President for remarks on Mr. Goode's paper, said:

In regard to the food of the menhaden, I have had occasion to see and feed them myself, both in the channels of Jamaica Bay and out in the sea, and they feed exclusively, as far as I know, on the small jelly-fish. They are from the size of a pea up to an egg. I have seen the menhaden in every direction in Jamaica Bay trying to secure these jelly-fish. I have seen them out in the ocean. Shad feed on the same thing in the ocean. I do not believe that the menhaden can plunge very deep; they do not seem to go below six or eight feet at the utmost. Many fish we know of cannot go beyond a certain depth. I do not believe that any fish live at the bottom of the sea during any time, though there are certain kinds that live at a great depth. I do not think mackerel go to any great depth. They live on the surface between twenty and thirty feet. The bluefish live on small fish. The reason why our fisheries have fallen off so much lately is, I believe, entirely owing to the bluefish on the coast. In 1840 I passed the summer at Newport, and we used to catch there bass, mackerel, and bluefish. From 1845 bluefish began to increase in size, and if you cut them open you find them full of small fish. Now they reach eighteen pounds, I believe. There is a limit to every species of fish. It would be curious to know what the extreme weight of fishes is. These bluefish every year, for thirty or forty years, have been increasing in size. They grow more slowly

after reaching a certain size. They reach two pounds probably in two years, and then they grow more slowly.

THE PRESIDENT: You have the credit of introducing the carp into this country.

MR. BREVOORT: I had nothing to do myself with it. Mr. Bell had introduced the carp at Troy, and was quite successful with them; but his dam gave way once, and all his carp went into the North River. I have received carp lately from the North River, and found it was the small carp, not the large carp. The carp is probably not much better than some of our suckers, but with good cooking it is a very good river-fish. Old stories in Europe say that you can send a carp a six days' journey and it will live. There is a story of a carp which was sent to Paris, and nobody wanted it, and it was sent back to Strasbourg and put in the pond alive.

Exception was taken by a member to Mr. Brevoort's statement as to the introduction of carp, it having appeared that carp were introduced into this country by Captain Robinson.

PROFESSOR BAIRD, United States Commissioner of Fish and Fisheries: In regard to the food of the menhaden I have had many of them—thousands of them—and examined the contents of their stomach, and I always found the stomach loaded with black organic mud. It is said by fishermen that mackerel plunge after the small jelly-fish, and eat out the centre of them. I have had a collection of mackerel stomachs since last fall, and in one specimen we found thirteen young fish of different species. We know that the mackerel do eat young fish, the shrimp, &c.; but after an ex-

amination of the stomach of the menhaden we were induced to believe that they feed upon the bottom mud. The menhaden is just the same kind of food and the same stomach as the gizzard-herring and the gizzard-shad of the South. What Mr. Brevoort has said as to the surface-living of the mackerel is true, but there are departures from this. In regard to the question of fish-food, we know that the menhaden is carnivorous, but as far as we have any evidence from examining the stomachs, it seems that the mud supply has rather the first place. Professor Goode stated in regard to the plunging of fish into deeper water, that experiment had proved that both the menhaden and mackerel have the power of plunging to great depths.

Mr. Frederick Mather produced a little fish in a bottle, which he said he picked up on the ship's deck, two hundred miles this side of Queenstown, and put up in the little bottle in which it now was, and that it had proved to be very valuable, only one other specimen having been found.

Mr. Frederick Mather read a paper on the Feeding of Fishes in Confinement.

I think that the first intimation which I received that possibly our system of feeding fish on liver and lights might not be the best that was possible, was furnished not by a fish itself, but by an animal as low in the scale as a zoophyte. It may be as well to explain to those who are not familiar with them, that anemones have but one orifice to their digestive system, which serves all purposes of inlet and outlet. The stomach is a simple bag into which the mouth opens directly, and when the animal takes food it closes like a flower, the stomach pours out its secretions and dissolves

such parts as may be digestible or required at the time, the remaining portions, as fish-bones, shells of crustacea, etc., are ejected, and the anemone has dined.

One day a lady brought me one of her pet "sea-flowers" in a fruit-jar, where she had kept it for a few days while cleaning its vase, and said that it had refused to feed for several weeks, would take particles of beef, partly swallow them, and in a moment cast them up.

It was a fine specimen of *Actinolobe dianthus*, which nearly filled the jar when fully expanded, affording an excellent opportunity to study it in the comparatively small space. It did as related with shreds of beef, whereas it is usual for them to remain closed for some time after taking food. I then tried it with a piece of fish, which it took and remained closed for two hours, when it opened and threw out a glairy substance with small particles of the food.

Here was the solution: it had fed upon beef until tired of it, the hard muscle was not easily dissolved, or what is more likely, did not contain exactly what the anemone required.

I had noticed that when a shrimp was caught, it appeared to be entirely digested except the crusts. Two days afterward the lady called, and was highly delighted with this small leaf from the "Book of Nature," vowing never to offer it beef again. I was a long time in finding the proper food for the Hippocampus, or in fact in getting them to notice anything; but as this concerns the naturalist more than the fish-culturalist, we will pass it and kindred examples, and only consider those that have a bearing upon practical fish-breeding in which the members of the Association are particularly interested.

All are familiar with the difficulty in feeding shad and

whitefish; the former can, with our present knowledge, be fed only by introducing fresh water from a stream containing their living microscopic food, paying no attention whatever to particles washed from a piece of beef or fish, at least, as far as my own knowledge extends.

Then observe the hardy California salmon how it thrives on liver finely chopped, although I question if chopped fish, earth-worms, or the small red worm from the mud of trout-streams, if they could be obtained in quantity, or, in fact, any of the softer and more easily dissolved flesh of the kinds named, or crustaceans, would not be better, although liver and the other gland, known as spleen or milt, is far softer than the muscular fibre of beef. Fish and shrimps are more easily digested by anemones, as has been shown, and most likely are equally suitable for fish themselves as being their more natural diet.

Our young brook-trout do not do so well on liver, but in the first months die freely until accustomed to the unnatural conditions, all the weaker members, like the "good," die young.

Here are instanced three kinds of fish: the first rejecting all that man offers that in any degree differs from what nourished its parents; the second growing comparatively well on strange food, but never making as rapid growth, partly owing to confinement in small space; and the third occupying a position between the two, with only the "fittest" surviving.

I cannot think that the great mortality in young brook-trout at the time they begin to take food is at all a law of nature, but rather a deficiency of some important condition necessary to their existence.

While engaged in trout-culture some years ago, I fed my

adult fish on "lights," as the lungs of beef are called, and when one died, often opened it to look for the cause of its death, without getting a very definite idea of it, as at that time I had not paid any attention to anatomy. Occasionally it was plain to be seen by the protruding eyes and inflammation of the brain where the trouble was, but of the cause of it I do not know to this day.

I do, however, distinctly remember many whose "large intestine" *was* large, with its surface showing inflammation, which I now attribute to large pieces of indigestible matter, perhaps the cartilage lining of the bronchial tubes in the food. I did not then know that the "large intestine" in many fish, as the genus *salmo esox* (the pike) and some others, is only so-called because it is analogous to that in the percoids, where it *is* larger. In the salmon's it is of the same diameter as the "small intestine," when it is in a normal condition. There is also a well-marked difference in the lining of the small and large intestines in the salmon; the beginning of the large one is well marked by a long circular valve, or transverse fold, one edge of which hangs free; this is followed by several smaller ones resembling those known as *Valvulæ conniventes* in the human small intestine. As I remember, the edges of these were highly inflamed, and in one case appeared ulcerated, and in fact there was more or less inflammation of the entire lining of the vasculo-mucous membrane, caused no doubt by the continual passage of large partly-digested masses.

Who that has seen it does not remember trout in ponds with a string of white, undigested fibre trailing six inches behind; which proves to be held very fast if pulled on, and which takes sometimes days to expel. Also note the appearance of the pendant matter from the wild trout, whose

food is insects, fish, and crustacea; how different, and how easily it is passed; compare also the appearance of the vents of the two fishes: one small, with its edges sharply and clearly defined, and the other large, swollen, and hemerhoidal in appearance. This, however, is only a *mechanical* objection; for as fish contain much phosphorus, they must require a supply of it in their food, instead of the nitrogenous element so plentiful in beef.

At our last meeting I exhibited to the Association the results of an experiment in keeping quinnat salmon at different degrees of temperature, and the wonderful difference in their size at three months old. I also made another one not reported. I fed a few on curd, but they did not do as well as those fed on liver; in fact most of them died at five months old. It is well known that salmon, though a very oily fish, has but little of that commodity in its liver, while the cod has plenty there, but only a small quantity in its body. These little fish seem to have an oily liver, much increased in size, without a corresponding increase of the gall-bladder, and while their general condition was poor, the intestines were loaded with fat.

I have found that gold-fish grow best on a mixed diet of worms and vegetation, especially those low forms growing in stagnant waters, on stones, etc., called confervæ, and also that a sea-fish, known as mullet (*muzil lineatus*) does not grow in size in aquaria if fed on fish alone, as they are mainly vegetarians, feeding on the red sea-weed, known as fucus, and which can only be grown in dark places. This was told me by several aquarium curators in Europe.

As another instance of the effect of feeding, I will say that I fed two small crabs on fish, and two on beef for four months; the former cast their shells and grew, while the

latter did not. This, however, was not continued long enough to be perfectly satisfactory, and the results require confirming.

The ever-shifting localities of my labors have for the past few years prevented the beginning of many most interesting experiments, and abruptly terminated others fairly under way, and I would be much pleased to have others follow these imperfect trials, and either prove or disprove the views that at present I entertain, and which, I think, are sufficiently indicated by the tone of this paper.

THE PRESIDENT called on the United States Commissioner of Fisheries for some information in regard to statistics of fish in this country.

PROFESSOR BAIRD: I suppose you refer to statistics of production, showing a comparison between that of this country and Canada. I would say in this connection that I was in attendance at the Fishery Commission, at Halifax, last summer, and found there the great necessity of coming to an appreciation of the great deficiency of our statistics. The Canadians have great facilities by which they get under almost a single head the statistics of nearly all the fish in the dominion. The results are very satisfactory and desirable. They have paid fish-inspectors, who are stationed along the coasts and gather in the number of fish taken, and report that number to a superior officer, who adjusts and tabulates them, so that at the end of the year they can get a complete account of every barrel of mackerel, every quintal of codfish, every pound of trout, and all the bass, and all the oysters, and all the products of the sea. We have nothing of that kind in the United States. Last year the

Legislature of Massachusetts required all the fishermen of the coast to make a report to the state fishery commissioner. The latter sent out blanks to the fishermen, and they have just published a report of the year's operations. This is a good begining, and I hope will be continued; but with that exception, we have nothing of the sort in the United States. It is a matter of the utmost importance, as it is of the highest interest, that we should commence and have the facts reported. I have prepared, hoping that I might induce the fish-dealers of New York to make a beginning, statements of the number of fish brought in here from the Eastern coasts, with a view to have them used in correcting the figures in the books, so as to make up some sort of a statement of the fish-trade of the city of New York, and I will place those in the hands of as many as possible, so that we may endeavor as soon as possible to get these facts. I will be very glad to furnish to the wholesale dealers all the blanks I can. If we had had figures at Halifax, we might have done something to prevent the excessive award against the United States. I believe the American in-shore fisheries to be worth ten times as much as those of Canada. Though the Canadians do not use them, they have the right to do so, and if we had had these figures to show the enormous wealth of our fisheries, we might have done differently. I think we have lost millions of dollars by not having our catch of fish tabulated. Now this question must come up again. The provisional treaty began in 1873. It is now 1878, and within six or seven years more the question must be gone into over again, and I hope that by that time we shall have such figures as will enable us to hold our own in comparison with the statistics of Canada. And this is important, first, on account of the abstract propriety of having

these figures; and second, that we may have them for the use of our diplomatic agents in the future, and I hope all fishermen who feel outraged at this award will do their best to prevent similar penalties again.

PROFESSOR BAIRD stated that the forms he had contained the enumeration of fish that enter into the wholesale market, and the number of pounds of each kind held by each dealer, which could be recorded, and at the end of each month made up and the aggregate tabulated, and then put together and the whole given at the end of each year.

THE PRESIDENT: Last year our commissioner applied to the Legislature for authority to take some action in the matter, either to appoint a warder or counter, but no action was taken on the subject. The action was on account of a resolution passed in this Association last year, but nothing has come of it. We have frequently made individual applications to persons, and tried to ascertain that way, but that was equally unsatisfactory, and no practical result was obtained. If it is practicable, and any gentleman here will suggest whether it is possible to place the matter in a working form, so as to have the Fishmongers' Association acting either with this Association or with the commissioner, or with the United States Commission, no matter which, so long as the result is obtained, it will be very satisfactory to all of us, and whether a resolution had better be offered. If any of the Fishmongers' Association are present and will suggest anything, I would be glad to hear it. It has been suggested that we should invite the members of the Fishmongers' Association to be members of our Association. Our interests are identical. We are both dealing with fish. It is as important to the fishmongers that fish should be plenty

as it would be agreeable to us. We want fish to be plenty, not merely for amusement, not for sport, but as a practical question of economic benefit to the community, and it will benefit the gentlemen who deal in fish as well as anybody else in the community, so that our action really tends in the same direction. It has given us great satisfaction that the Fishmongers' Association invited us to meet here to-day. We feel that we are a little nearer to them. You are aware that there has been some slight feeling of jealousy between them and us. The fishmongers first thought that we had interfered with them, and a feeling of jealousy ensued. But this, I believe, has now entirely disappeared. There were gentlemen who dealt either directly or indirectly with the same subject of fish-culture, saying that it was a mere plaything, of no value practically, and was more theoretical than practical, both in process and results; but they, as well as we, are now, I believe, convinced that it is not so; that fish-culture has surpassed the expectations of those who took part in it, and I say that fish-culture can be made more interesting to those who take part in it, and I would like to see something decided come out of it in that direction.

The appointment of a committee to nominate officers for the ensuing year, and report the ensuing day, was then suggested.

MR. ROOSEVELT said a few words in favor of rotation of office.

The nominating committee was appointed.

THE PRESIDENT announced the report to the next section, "On Fisheries," would be presented.

The meeting adjourned till Thursday, February 28, 1877, at 10:30 A. M.

SECOND DAY'S PROCEEDINGS.

THURSDAY, February 28, 1878.

The President, ROBERT B. ROOSEVELT, Esq., having called the meeting to order, the Secretary proposed the following amendments to the Constitution of the Association:

First, That the name of the American Fish Culturists' Association be changed, and that of the American Fish Cultural Association be adopted.

Mr. PHILLIPS explained how the former title of the Association was a limited one, while the proposed change admitted of greater scope.

The resolution was adopted.

The SECRETARY proposed that the number of the Executive Committee be increased from three to seven members.

Resolution adopted.

On the report of the Nominating Committee the following officers were elected for the ensuing year:

President—ROBERT B. ROOSEVELT.
Vice-President—GEORGE SHEPPHERD PAGE.
Secretary—BARNET PHILLIPS.
Treasurer—EUGENE G. BLACKFORD.
Executive Committee—H. T. REEDER, FREDERICK MATHER, J. W. MILNER, W. F. WITCHER, SETH GREEN, and H. D. MCGOVERN.

MR. EUGENE G. BLACKFORD read a paper on the "Peculiar Features of the Fish-Market."

GENTLEMEN: Your section has thought it best to report upon the staple fish—shad, trout, and salmon—which are leading objects of sale at various seasons in New York.

The supply of shad was not remarkable, either as to size or quality, during the season of 1877. It was not abundant, either in Northern or Southern waters. In the South shad made its appearance about the usual time, towards the close of December in Florida, followed later with the fish caught in Georgia, in the Ogeechee, and ending for southern fish in shad caught in the Neuse River, North Carolina. These North Carolina shad are the best of the southern shad as to quality, and almost rival those fish caught in the Connecticut, both as to size and flavor.

In the Middle States, Virginia and Maryland supply but few shad to New York, a much smaller proportion coming from the Potomac than for several years past. One peculiarity of the shad of the Potomac, to which we would call the attention of the Fish Commissioners, is that the female fish are all very fully matured, with eggs much further advanced in condition than those of any other shad coming into the market. In these Potomac fish the quality of the flesh is somewhat impaired by this over-ripeness, being rather dry and insipid, in many instances the roe being worthless as food.

From the Hudson River we had hoped, during the last year, to have reaped a rich harvest, but we regret to say the yield was hardly up to the average catch of the last five years. Fully appreciating the work of the New York Fish Commissioners, and the great intelligence they have shown in their labors, we are more insistant than ever that

in order that we may derive any advantage from their efforts, that a law should be passed restricting fishermen from using their nets for at least one entire day in the week during the fishing-season, so that spawning-fish may have an opportunity to ascend the stream and effect their spawning. We are quite positive in asserting that until this is done we never shall be able to increase the number of shad in the North River. Young fish may be put into the river, but if we stop them when mature from ascending the river, we are working in a blind and senseless way. We call, then, particularly on this Association to give their aid, both individually and collectively, to remedying this over-fishing, and to use their efforts to induce legislators to pass such laws as will restrict the periods of shad-fishing.

In the Connecticut River the shad, as usual, surpassed all others as to flavor and size. We are forced to declare, however, from information we have obtained, that the catch here, too, was less than for a number of years. We are inclined to give the same reasons for the scarcity of shad in the Connecticut as are found in the Hudson.

It is not for a single year, then, that the efforts of legislation should be directed towards preventing over-fishing in a river, but for a series of years. If it takes, as it is asserted, three years to produce a crop of shad, in 1877 we caught all the fish which were bred in 1873. This spring we are about preventing the gravid shad, born in 1874, from reproducing their kind.

As to the price of shad during the last season, it must be understood as having but little to do with production. The price of shad is affected by a great many accidental causes. Shad may be in good demand in not very large quantity, when mackerel may come in and make shad very

cheap. We may state that the leading position shad occupied some ten years ago in the New York market as an article of fish-food has somewhat lowered of late. The reason is that New York, with increased facilities of transportation, draws to itself all the best fish of the seaboard, and is not as dependant as it used to be on a single variety of fish.

TROUT.

The consumption of trout (*Salmo Fontinalis*) has been notably increased in New York during the last three years. This increased favor in which trout is held is owing to the fact that its excellence has become more widely known. Special efforts have been made at the opening of the season to bring together on exhibition all the varieties of this beautiful fish. As many as thirty varieties of the *Salmo Fontinalis*, from the British provinces to California, have been displayed at one time in Fulton Market. It should be remembered that this year the season opens fifteen days later than formerly, it being against the law to sell or catch trout in New York before the first day of April.

In trout, the cultivated fish from Long Island stand the first in public favor, not only on account of their beauty, but fine flavor.

Owing to the depressed state of the times, trout being rather an expensive fish, at least when first brought into the market, they were not as readily disposed of last year as on former seasons. The average price was about eighty-five cents a pound for cultivated trout from Long Island. Some of the finest specimens were sent by Mr. Livingstone Stone, of Charlestown, N. H., which readily brought seventy-five cents a pound. Large quantities of trout were sent into market, raised by Mr. F. H. Douseman, of Wisconsin, who

is probably the most successful trout-raiser in the United States. Moose Head Lake, in Maine, as usual, sent the largest fish into market; but large trout are not the most esteemed. While fish weighing not more than half a pound fetch forty cents a pound, larger fish only bring from twenty-five to thirty cents. The supply of trout at present seems quite equal to the demand. In fact, as many trout are marketed as can be sold. We do not think that an excess of production with diminution of price could cause increased consumption.

SALMON.

We receive in New York salmon from the Pacific and Atlantic coasts.

From California the quantity of the *Salmo Quinnat* was not more than one-half of that received in the year before. The Pacific salmon is not as highly esteemed as the Atlantic fish, and does not command as high a price. When expense of handling and cost of transportation are considered, the margin of profit is quite small. This business in California salmon is due very much to the enterprise of Mr. A. Booth, of Chicago.

Of the Atlantic salmon (*Salmo Salar*) we are pleased to state that the quantity sent into market was unusually large. Owing to improved facilities in transportation we can obtain fish from new sources. We can get our fish at first hands from the Bay of Chaleurs, from the Restigouche and Mirimachee Rivers. The salmon caught in New England form but a very small fractional proportion of the total quantity, though they command the highest price. Salmon never were as cheap as during the season of 1877, good, sound fish retailing as low as ten cents a pound. The first salmon coming into New York are derived from the pro-

vinces, and when arriving in the latter part of February will bring as much as $1.50 a pound. The consumption of salmon, we are glad to say, has been very much increased by its cheapness. If it were not for the methods of refrigeration, which prevents a glut in the market—which process absorbs the surplus—salmon might be sold at six cents a pound.

In presenting to the notice of the Association the three fresh-water fish most in use in the markets, it happens that all of them are especially of the kinds to which your labors as fish culturists have been directed. It is to these particular fish, as objects of commerce, then, that we have more particularly directed our attention.

To conclude the report of your section, we may allude to the pompano. Having in former years, after some slight difficulties, succeeded in introducing this most delicate of all fish—a fish which we believe to be the finest of all table-fish, being in fact the rival of the turbot—we have to note that the pompano last year was rarely received in our markets from Southern waters. The supply from Norfolk and from Chesapeake Bay was almost entirely wanting. Perhaps the Commissioner from Maryland can inform the Association as to the peculiarities of this fish in the waters over which he has supervision.

Referring once more to salmon, and endeavoring to account for its great plenty in the waters of the Dominion, we think we can see very clearly why the fish have been in such abundance. It is because the provincial commissioners have wise legislation to back their efforts. Granting their well known skill as fish culturists, we believe their efforts as to the introduction of young salmon in their waters would be of little avail if it were not for their care and

watchfulness in carrying out the law, which prevents the fishermen from catching salmon day in and day out during the open season. Fish have, then, in the waters of the provinces, a breathing-spell. Gravid fish may mount the stream and reproduce their kind. The decreased catch of salmon on the Pacific coast this year may perhaps be attributed to this want of care in providing for certain close-days. We believe, then, with regard to shad at present, and for salmon in the future, that without some protective legislation we shall never be able to gain the full benefit of the harvest sown if we consume the grain entirely, keeping none for the seed.

THE PRESIDENT: I will say in confirmation of Mr. Blackford's paper, that the necessity of a closed term, especially for shad, was manifest to the New York Commissioners when they were appointed in 1868. It was necessary that for at least one day in the week the fish could go through the barriers to their spawning-ground. That was strongly recommended, and a law authorizing a weekly closed term, from Saturday to Monday, was recommended and drawn up and submitted with their report. No notice being taken of it, it was in the second year again recommended and submitted, and the same result following, the same thing was repeated the third year, and so we went on for four or five years, pressing this closing strongly on the attention of the Legislature, but not lobbying to carry it through, because we thought that improper and undignified, until at last we made up our minds that we would have to get the community waked up. We considered that it was necessary to fill the North River with at least two hundred millions of shad. The greatest number of eggs which we could obtain did not reach more than ten

or twelve millions, and no more could be done until this closed term was increased. The difficulty has gone on. The fishing increasing as the fisheries improved. I am very glad that Mr. Blackford has presented this subject as he has, and I hope that it will meet with such support as will enable us to get more closed time, if not for two days, at least for one.

MR. GREEN said: Beginning where the President left off, the fact is that there are now twenty fishermen where there was one when we commenced shad-hatching. The consequence is, as he says, that so many do not reach the spawning-ground now as when we commenced. The farmers and everybody that had nets and used to put up their fish year after year, had stopped fishing, because it was too much labor to get them; but now, unless we have a closed term, so that the fish can get to the spawning-ground, they will run out in time. Our great opponents in this have been the net-fishermen at the mouth of the river. Above that, every man wants a closed time; but, he says, "Every one is going in, and I will go in too;" and they do, and catch all they can. Now, if we can get twenty-four hours' closed time, we can hatch several million more fish in the North River. Mr. Blackford was talking about the Hudson River shad in the New York market, that it had decreased, instead of increasing. Well, the Western people have learned that they can get shad, and now all our Western markets are furnished with shad. It is sold in the market, and has been for the last five years, from Albany to Buffalo, for twenty-five cents apiece—No. 1 shad, too. We never had those before, not in twenty years; but now we have No. 1 shad, and get them from the first hands, not from the second

dealers, and therefore we get much nicer fish and save expense. Well, anyhow, they have learned that they can get shad in the Western country, and they do not come this way, they go that way; that is all. But to return to the nets. The river is full of nets from one end to the other—pound-nets at the mouth of the river enough to stop a locomotive if it came that way—and the nets are set during the spawning-season. Now, how can it be expected that the fish are going to be kept up if the facilities for fishing continue as they are now, unless by artificial propagation; and it can be done by artificial propagation; and one of the greatest mistakes our United States Commissioner has made is in not stocking these waters as they should be. They should have been stocked with whitefish and trout ever since the Commission has been in existence.

THE PRESIDENT: Has not the yield of spawn obtained the last year or two on the North River diminished?

MR. GREEN: Yes; for the cause I have explained. There are more fishermen than there were before, and they stop the fish before they get to the spawning-ground.

THE PRESIDENT: Would not a closed term give us that fish?

MR. GREEN: Yes. Give us a closed term, and we will fill the North River with shad.

THE PRESIDENT requested Mr. Campbell to give the meeting his views in regard to pound-netting on the Jersey coast.

MR. CAMPBELL: Previous to the introduction of pounds there was no difficulty in getting a boat-load of fish. About five years ago they commenced putting down pounds early in the season. In time it was usual for the weakfish to

come into the bay or river to spawn. When I moved down in May, these pounds were as full of spawn as they could be, and the next year it was a rare thing to catch a weakfish. These pounds took all the weakfish that came in, and when there was no market for them, they were dumped out. I have seen thirty bushels dumped out in the lower bay. A fish that escapes these pounds is a very clever fish. I suggested to the President before the meeting that it would be difficult to suppress the laying of pounds. In Massachusetts there is a law to compel the owners of pounds to leave them from Friday to Monday, for the purpose of giving the fish power to spawn. I would suggest that it would be well if we could make the fishermen understand that it is for their benefit to have a law passed. Bass-fishing and weak-fishing will be stopped in New York altogether soon if this is not done.

DR. GREEN: I am familiar with South Bay. What Mr. Campbell says is precisely the case in South Bay.

MR. SETH GREEN: I perfectly agree with what these gentlemen have said. Permit me to say a word about the locality of fish. Fish are local. There is a certain fish that goes into a certain water—the Great South Bay we will take for an example. There is a family of fish that never go into any other bay but Great South Bay, and these nets set across the inlets will in a very short time clean the whole thing out, and there never will be in this generation any more fish there, unless they are hatched artificially. I will tell you something about pound-nets. It is a fence made with nets, and on the head of it is a trap which takes everything which comes along. The trap is as effectual as if you put up a fence outside your field, and there was nothing there that looked any different from the regular cattle-place,

but when the cattle came through there they dropped into a pit. Well, the pound-netting started in the New England states, exhausted some localities there, and then came West. Say that they came to me. I own a fishery. I have a place where I haul a net. It was a nice bay, and everybody had a little net all around it, and caught fish, and did a good thing. I lived on the corner of one of these points, and there was my fishery, the best fishery on the bay. A man comes to me, and says, "Mr. Green, how many fish did you catch last year?" I tell him so and so, which brought me so many dollars good to windward. He asks, "Why don't you set a pound-net over here?" I reply, "I haven't got the means; it will cost $1,000 or $1,500." "Well," he replies, "I will furnish the net, and I will come and set it and show you how to work it, and give you half what it takes." "All right," I say. Then this fellow goes to the other side and says the same thing to the other man, and so on, and they all say, "All right; we will do it." He comes with his nets, and shows me how to work them. It is a big thing. I get all the fish I want. I am tickled to death over it. Next year I don't get quite so much, but still it is a pretty good thing. The next year, along towards the end of the fishing, he comes along, and says, "This is a good thing. You ought to own this. It seems to be a pretty good thing." Well, that is the end of it. The fellow knows that we have caught all the family of fish that come into that bay, but I do not know it. He is smarter than we are. It is the family of fish that live in that bay that we have caught there. Well, I say to him, "How much will you take for the net?" He says, "About half what it cost." The fact is, the thing has gone up; but I want to get rid of giving him half the profit. Well, I

have not quite money enough to pay for the net, but I mortgage my place. Yes, he accepts the mortgage. Time goes on. The next year I set my net. The fish do not come. The next year I patch up the net, grow poor, live on liver, and all sorts of things. Well, I get through that year. About the end of three years he comes around. I have no money. My children are all ragged, the fish are not coming, and I am giving out, and my place is sold for the mortgage. I know lots of places that have gone up the same way, and I know lots of men who have sold their places the way I have told you.

PROFESSOR MILNER read the following paper on "The Work of Shad-Hatching on the Head Waters of Chesapeake Bay," describing a new plan of hatching-machines.

The work of shad-hatching in 1877 and distribution on the part of the United States was carried on as in the previous years in connection with the Commissioner of Maryland, Major T. B. Ferguson. No work was done south of the Susquehanna, at Havre de Grace. The Maryland Commission began operations about the 8th of May at Havre de Grace, Maryland, near the point where the Susquehanna pours its waters into Chesapeake Bay. The seines and gill-nets in this vicinity are very numerous, and by stationing men at points conveniently near two or three nets a great many fish can be handled. On the night of the 14th, Major Ferguson's men took 1,250,000 shad-eggs. About this date, having received word from Major Ferguson that he was ready for coöperation with the United States in the work of hatching and distribution, we went to Havre de Grace with a force of men, and between that time and the 13th of June

1,495,000 fish were distributed in waters of the southern Atlantic coast, tributaries to the Mississippi, and to the Sacramento, of California. Altogether, at this station, under the joint work of the State and United States, about 8,444,000 fish were hatched, the larger portion being consigned to adjacent waters.

The hatching was done with a novel and exceedingly efficient apparatus, which marks one of the greatest advances in fish culture yet made. It must certainly appear to you as a novel proceeding to hatch fish by steam, but this is precisely what we did. We didn't steam the eggs in a cullender, but a ten-horse-power steam-engine was set in motion at a slow revolution. A long shafting with eccentrics moved the long arms of the levers up and down, and suspended from the ends of the short arms were sheet-iron cylinders, with wire-netting bottoms, half-submerged in the river. The slow up-and-down movement, when a quantity of eggs were put into the cylinders, kept them in gentle motion within the arms until they were hatched. As the engine and machinery were fixed upon a large scow anchored out in the stream, it was possible to have levers projecting on each side the inner ends, being coupled in a sliding knuckle-joint, so that one eccentric moved both.

The fish hatched with perfect success, and proved vigorous and hardy in the longest trips made, as the one to California.

There are great advantages in this apparatus over any previously used for the purpose. The more especially desirable features being the possibility of complete success when there is no current whatever; the advantage that the cylinders can be closed with wire-netting covers, and when the temperature rises to a dangerous point they may be

sunk to the deeper, cooler strata of water, and the eggs kept in motion the same as at the surface; the portability of the whole apparatus over and to all new points for work. The covers similar to the Bell & Mather apparatus, but considerably improved, were also used successfully.

Early in July operations were begun at South Hadley Falls, Mass., and at the time the work closed, July 25th, about 3,018,000 were distributed and turned into the Connecticut.

To sum up, 110,000 shad were sent to California, 1,263,000 were put into tributaries of the Mississippi River, 1,365,000 in the South Atlantic and Gulf rivers, and 1,588,000 in the streams of New England, the larger portion in the Potomac—in all about 4,500,000 shad.

At South Hadley Falls, Mr. Charles G. Atkins conducted a series of experiments on the estimation of shad-eggs, and is disposed to reduce the standard of estimation about 20 per cent. below that we have used. There have been reductions of the standard from time to time from the first hatching of shad. Whether there is necessity for so great a reduction I shall be better able to say after testing the matter the coming season.

Mr. Green differed as to what was (alluding to the apparatus described) the best apparatus for shad-hatching. Some years ago, Mr. Green stated, the New York, Massachusetts, and New Hampshire Commissioners wanted him to come and hatch shad. He went, and got up a box to hatch shad with, and hatched 15,000,000. (Mr. Green described the hatching-apparatus by a diagram on the board.)

A discussion arose in regard to certain infringements of patents, as alleged by Mr. Green.

MR. ROBERT B. ROOSEVELT read a paper on the "Reproductive Power of Eels."

REPRODUCTIVE HABITS OF EELS.

The trout-ponds on Long Island are infested with eels, which are undoubtedly very injurious to the fishing and destructive to the trout. These ponds communicate directly with the Great South Bay, which is a long and narrow lagoon on the south side of the island. Eels are not only taken in the ponds, which, of course, are wholly fresh, cold, and springy; but in much larger numbers in the saline water of the bay, which is strongly impregnated with salt, although somewhat less so than the ocean. Having purchased a country-place, including a trout-pond, on Long Island, I determined to study the habits of these fish, which, while pernicious to trout, are exceedingly beneficial and valuable to man, and of which little has been accurately determined. With this object in view, I built below my pond two small preserves, leading one into the other, and the upper one connected with the main pond by a wooden trough. In the lower pond I had nothing at first, but afterwards some trout of from one-quarter to one-half a pound in weight. In the upper preserve were placed six hundred California salmon, from those hatched in the New York Aquarium, and the trough was half-filled with sand and gravel to hatch a few thousand trout-eggs. These arrangements were merely temporary, as I had great doubts about their working satisfactorily. Nearly ten thousand trout-eggs were laid down, and hatched beautifully by April 1st, the loss being immaterial. A few young eels, not thicker than a lady's hair-pin, and one inch and a half long, passed the screens, and were seen in the troughs. They

were semi-transparent, evidently just hatched, and came from the pond. They grew rapidly when not killed, and some escaped our notice. During my temporary absence I was informed that they were eating the trout-fry, and although I returned on April 17th, many of the latter had been devoured. In moving the rest, I had to dig up the sand, and found it filled up with eels from two inches to six inches long, which had buried themselves in it, and were hidden away wholly out of sight. There were three screens of fine wire-netting in the trough—one at the head, one at the foot, and one between the two. Now that the sand was gone, the young eels were to be seen in myriads passing from the main pond down the trough, and thence into the first preserve. The salmon had grown so large that they would occasionally eat one, and in the lower pond were now the large trout and few or no eels.

It was impossible that the eels could have come up stream from the salt-water bay, as the discharge from the lower preserve was through a pipe, also grated, which had a fall of two feet perpendicular clear of the bank. Besides, we saw them descending the trough in black masses, and while doing so they endeavored to get through the lower screen, never seeking to pass the upper one. By April 26th, as they collected at the lower screen, they were taken out by millions in a small net, made for the purpose of mosquito-netting. Most of them were so young that the heart could be plainly seen, and its pulsations, which were rapid, noted under a microscope. I could find nothing of the supposititious heart in the tail, and I decidedly doubt its existence; but my magnifying-glass may not have had sufficient power. In a few days after their first appearance the young eels would lose their translucent color and became black and

opaque, with the delicate seration on abdomen and reticulation on their sides of the perfect eel. Towards the last of April the supply of young diminished, and we almost cleared the trough and upper preserve of them. There never were more than a few in the lower preserve, but by May 19th they were more plentiful than ever, and as the lower screen in the trough had been removed, they poured into the upper preserve in myriads.

Now, none of these eels came from the bay. They were all descending from the pond, where they must have hatched or been born. To be sure, they kept their heads up-stream, but fish of all kinds in descending a stream invariably do that, as every one who has watched them knows, and for the reason that in that way they can escape danger, and can regulate their rate of descent. Salmon descend rapids and shad go down our rivers head up-stream; and so does every kind of fish when left to its natural course. It is true they would occasionally climb back up the side of the preserve, into which they had wormed their way with so much persistency, but that was probably due to eel-perversity. It was seeing them climb perpendicular flood-gates in that manner which had convinced me, as no doubt it had convinced others, that eels were ascending, not descending, the rivers in the spring. If my present conclusion is right, it accords with the practice of all migratory fish, and brings eels into the ordinary catalogue of breeding in fresh-water and growing in salt. It seems to me impossible that I could be deceived. There were very few eel-fry in the main stream, into which the preserves emptied; there were scarcely more in the lower preserve, through which alone they could obtain access from below to the upper preserve. In the latter they existed in millions, their numbers increasing im-

mensely about May 1st, when the lower screen in the trough was removed, and in the trough they were also found in solid masses of wriggling life. Eel-pots were set during this time in the main pond, and caught some large eels, but none of these contained spawn, and I have no knowledge whether they are viviparous or oviparous. But I am firmly persuaded that the supposition that they produce their young or deposit their eggs in the salt-water is a mistake.

In the preceding year they had been in inky lines of countless numbers in the main stream. They had probably gone down the fish-way, which is placed in the dam at the flume; but last year they discovered the new and more feasible passage of my breeding-trough, and followed it, none, so far as I could ascertain, having recourse to their former method of descent. A few were seen at the outlet of the pipe which supplies the hydraulic ram, that is fed from the pond, but none, comparatively speaking, were to be seen in the stream below the pond or preserves. The trough and preserves were an effectual eel-trap, from which I sent thousands of eels to other parts of the country, and which proved a good method of eradicating what I regard as the most fatal enemy of trout in Long Island waters.

One event occurred, which at first seemed inexplicable, but which finally confirmed my theory. About May 22d, and when they had been over a month with me in immense quantities, and in spite of my efforts at extermination covered the upper part of the bottom of the first preserve in black masses, they suddenly disappeared. In a single night they seemed to leave together. At the time I was utterly puzzled to determine what had become of them. I wondered if they had hidden themselves in the sand and gravel at the bottom of the preserve, or whether they had climbed

over its sides during a shower which had taken place. This result seemed at first to cast doubt upon all my conclusions, but when I discovered, as I did by accident, the true explanation, it confirmed, as I have said, my previous deductions. The sides of the preserves were boarded up, and the water had worked its way through a knot-hole, not into the lower preserve from the upper one, but directly into the stream. The eels had found this out, although it was wholly under ground, not much larger than a lead pencil, and not visible on the surface, and had followed it down all together and the moment it offered them a passage to the salt-water without danger of encountering the ravenous jaws of their enemies in the lower preserve. Nothing could prove more conclusively that the eel-fry were descending and not ascending the brook than their immediately taking advantage of this opportunity when it presented itself. They had undoubtedly been waiting for just such an event. When I discovered it and proceeded to fill it up, I exhumed an eel of nine inches length remaining in it, and waiting, perhaps, to devour such of his brethren as might come along and were of appropriate size. I can see no escape from the inevitable conclusion from these experiments.

The accepted opinion of their method of reproduction goes on the idea that they deposit their spawn in the salt-water during the winter or early spring months; that the spawn hatches in the months of April and May, and that the young ascend the streams in May to find some suitable mud-endowed pond where they can live, luxuriate, eat, and grow fat. All this is contrary to the habits of every known variety of fish, and was only approved after considerable investigation, and on what seemed sufficient evidence; but there was always more or less doubt about it, and it required the

confirmation of the actual taking and hatching of the eggs under those conditions. These eggs, however, were never found in salt-water, nor, for the matter of that, anywhere else, and I too have not found them, and consider it possible that eels are viviparous, and produce living young. Certain it is that the oldest fishermen assert that they have never seen eggs in eels anywhere or at any season. But, unfortunately, fishermen, both the oldest and youngest, are like the rest of the world, and never seem to see anything, even when it is perched on the ends of their noses, if they did not expect to find it there.

It will be of interest to cast a glance on the endeavors of the more distinguished naturalists to find the ovaries and the spermatic organs of the eel, and on some erroneous assertions with regard to this matter, and for this purpose I quote from the last Report of Professor Baird, United States Commissioner of Fisheries.

Aristotle (fourth century before Christ), the greatest naturalist of antiquity, the founder of zoology, recognized the ovaries of the "grongo" (*Conger vulgaris*) by the cracking of eggs when placed over the fire, but maintained that the eel, notwithstanding that its ovaries resemble those of the "grango" in every respect, is born from worms produced by mud.

Pliny (first century A. D.), who in great part, like a majority of his compatriots, only copied Greek works, especially those of Aristotle, differs from him as regards the reproduction of the eel, maintaining that it rubs itself against rocks, and that from the fragments coming off during this rubbing process the young eels are born.

Albertus Magnus (thirteenth century A. D.) accepts Pliny's

hypothesis, but says that he has heard that eels are also born alive from eels.

Rondelet (sixteenth century A. D.) asserts that eels are born not only from putrefied matter, but also from eggs produced by the copulation of male and female eels.

Conrad Gesner (sixteenth century) attributes the reproduction of eels to putrefying matter, and also to copulation.

Walpiglie (seventeenth century), a great naturalist and expert microscopist, declares that the ovaries, not only of the eels, but also of similar fish, such as the "grongo" and the "murena" (*Muraena helena*), are fatty productions, and calls them "*striæ adiposæ*."

Redi (towards the end of the seventeenth century), who has dissected many eels and "murenas" (*Muraena helena*), and also illustrated as such the ovaries of the last mentioned fish, nevertheless does not recognize the ovaries of the eel. He opposes the hypothesis that the eel can be reproduced from putrefying matter; he proves, moreover, that what are called young eels are nothing but intestinal worms, and therefore eels are not viviparous animals, but are reproduced by means of eggs in the same manner as other fish.

Leuwenhœk (towards the end of the seventeenth century), who has occupied himself much with microscopic observations, and was the first who made known the *infusoria*, having found in the urinary bladder of an eel very small parasitic worms, mistook them for young eels, and the bladder itself for the uterus.

George Elsner relates that a fish-vender showed him an eel whose uterus was full of young ones, which, to quote

his own words, *hærebant in diversis membranis involutæ anquillæ.*

Vallisneri (beginning of the eighteenth century) has given illustrations of the true ovaries of the eel, but, following Walpiglie and Redi, calls them *vasi adiposi* (fatty vessels); and having accidentally found in an eel a pathologically-deformed swimming-bladder, announced with great joy to the Academy of Bologna and the whole scientific world that he had found the true ovary of the eel.

Luine maintains that eels are viviparous.

Carlo Mundini, Professor of Anatomy at the University of Bologna, was the first discoverer of the ovary of the eel, of which he gave a detailed description to the Academy of Bologna the 19th day of May, 1777, which, however, was not published till 1783.

Otto Müller writes, in 1780, that he has found eggs in the fringed bodies, but the description which he gives of them being in some respects inaccurate, preëminence must be accorded to that of Mundini.

Shallanzani, a distinguished naturalist, who lived towards the end of the eighteenth and in the beginning of the present century, basing his opinion on the examination of four hundred and ninety-seven eels, casts doubts on the discovery of Mundini, remarking, "That not content with destroying, he wishes to erect on the Vallisnerian ruins a new edifice." These words, however, lead us to suppose that a certain animosity towards the anatomist Mundini, whom he possibly considered as an intruder among the zoologists, has led his judgment astray. In another place, moreover, he contradicts himself when he adds, "If the masses of little globules were eggs, and if they were found united with the fecundating emen, the eels would be true hermaphrodites."

I cannot say that I have solved the doubts and questions which are here raised, but I think I have gone a step towards it in showing that the spawn of eels, when mature and extruded, must be sought for in fresh, not in salt-water.

In response to a question of the President, Professor Baird said: We have within six weeks received eels with ripe ovaries. I will say without hesitation that we have eels with ovaries extended and eggs nearly ready to be discharged—not hatched, but showing the eggs separate from the ovaries.

THE PRESIDENT: Did you find any males?

PROFESSOR BAIRD: No.

THE PRESIDENT: Did you find anything to lead you to suppose that they were hermaphrodite in their character?

PROFESSOR BAIRD: No; that was the theory of the Italians, but that theory is exploded.

MR. HEWITT: I have heard with great interest this subject of eels. In Pennsylvania we have never, as far as I know, discovered eels of the size you speak of in the headwaters of the Juniata or the Susquehanna. It is stated somewhere that it took 2,000 years in conflict of opinion to discover the ovary of the eel, and that is confirmed, in my opinion, by what Professor Baird has said.

PROFESSOR BAIRD: There is no doubt but that there are males and females—ovaries and spermatazoa.

PROFESSOR GOODE said that in Connecticut he had frequently found young eels, not more than an inch or two inches in length, along the shelly banks of the shore at low tide. These were quite immature. They were taken in the net when the net was full of the thrown-up seaweed. They

were brought inshore in great quantities, and we have many specimens, some not so much as an inch in length, and those young eels were in precisely the same localities where the large eels were in greatest quantities. The young were sufficiently abundant to warrant the assertion that the supply was not diminishing but that there is a young family of eels coming up every year.

AFTERNOON SESSION.

PROFESSOR GOODE produced a paper on "Statistics of American Fisheries." In introducing the subject, he said: Professor Baird, in his report yesterday, treated of the importance of exact statistics for many purposes, and especially for use in the diplomatic relations of the government of the United States in treaties between Canada and this country. When the United States Commission was summoned to Halifax last summer to give evidence before the Arbitration Committee, which was composed of a commissioner from the United States, one from England, and one appointed by the Emperor of Austria, to decide the question of the claim of the Dominion of Canada for remuneration for the use of their fisheries, it was found that the United States had almost nothing in the shape of exact statistics to offer. The Canadian government, on the other hand, had very valuable reports, collected by government officials for many years, in which the statistics of fisheries were given in the fullest detail. In order to offset these statistics of the Canadian government, it was necessary to compile some sort of a counter-statement, giving the value of the United States fisheries; and this was done from matters in the records of the United States, from statistics furnished by various gentlemen, among whom was Mr. Blackford, and from replies to letters sent to

various fishermen, and from these datas there was filed a statement. The most important is our oyster-fishery. It is a disgrace that we have no statistics. The only means of ascertaining the annual trade in oysters is from a report to the French government by Lieutenant P. de Broca, of the French navy, who was sent here in 1869 to investigate oyster-culture in the United States, and it is supposed that there has been no diminution since. He made a complete report, and this report will be found in the report of the United States Commissioner.

In 1875 the total amount of sperm-oil from the American whale-fisheries was 1,000,951 gallons; of other whale-oil, 1,414,186 gallons: in all, 2,505,137 gallons. The amount of menhaden-oil for the same year was 2,681,487 gallons, an excess of 176,350 gallons. In 1874, the amount of menhaden-oil was 3,372,837 gallons, which was very much in excess of whale-oil for the same year. In 1876, 2,990,000 gallons of menhaden-oil were made, and in 1877, 2,426,000. For the year ending June 30, 1877, the production of whale-oil was 2,140,047 gallons, and for the year 1877, 2,151,765 gallons.

In the *Oil, Paint, and Drug Reporter* for January 14, 1874 (page 4), the following statement is made:

"It is asserted that while the amount of oil produced is equal to that derived from the whale-fisheries in this country, the menhaden interest is ahead of the whale; for though the menhaden-oil sells at a less price per gallon, for every barrel of oil made there is three-quarters of a ton of scrap, which readily commands $15 per ton at the factory."

The oyster-fishery is by far the most important of the fisheries of North America, its value being at least double that of all the other fisheries together. It is a national disgrace that there are no reliable statistics of this industry.

There has been no statistical inquiry into the subject since 1869, when M. P. de Broea, a lieutenant in the French navy, was sent by the government of France to this country to investigate the subject of oyster-culture. De Broca published an elaborate report, which is reprinted in the Report of the United States Commissioners of Fisheries, 1876. He estimates the commerce of New York in this direction at $5,000,000, and that of the whole country at $50,000,000, although these figures were not supposed to represent the total amount of products, since along the coast and the rivers there is a daily consumption which cannot be estimated.

The *Merchants' Magazine and Commercial Review* for 1859 estimated the trade in oysters in the principal cities as follows:

	Bushels.
Virginia (State)	1,050,000
Baltimore	3,500,000
Philadelphia	2,500,000
New York	6,950,000
Fair Haven	2,000,000
Other cities, such as Providence, Boston, &c	4,000,000
Total	20,900,000

Calculating 200 oysters to a bushel, we here have the enormous amount of 4,000,000,000 individual oysters consumed.

The cod-fishery is the most valuable of the fisheries proper, the proceeds of the United States fishery in 1876 being estimated at $4,825,000. The number of pounds of fresh fish is put at 214,000,000 pounds, or hardly half the amount obtained from the menhaden fishery; 25,000,000 pounds are brought fresh to market, and the remainder is salted. About 200,000,000 pounds are estimated to be obtained from the off-

shore banks by regularly equipped vessels. The largest supply is, of course, obtained from the banks of Newfoundland. This is many times the most productive fishing-ground in the world, and has been frequented by English, French, and Dutch vessels for over three hundred years. The export of Newfoundland in 1876 represented about 390,000,000 pounds of fresh fish (1,300,000 quintals); the entire catch of the French fleet about 56,000,000 fresh fish (500,000 quintals); the entire catch of the Dominion fleet 250,000,000 pounds. In round numbers, the yield of codfish on the fishing-banks of North America in 1876 cannot have fallen far short of 1,000,000,000 pounds. The whole amount taken on the coast of Northern Europe does not probably exceed half that amount, while the catch from the North Pacific is probably not more than 5,000,000 pounds. The intrinsic value of the annual catch of codfish for the world, at five cents a pound for the green fish, is not less than $75,000,000, and their value is considerably increased by the process of curing.

Codfish are found on all soundings of less than two hundred fathoms in the North Atlantic. To the north they range far beyond the Arctic Circle, on the eastern side to Spitzbergen (lat. 78 deg. n.), and on the American coast to Davis Straits at the Riscoll Bank (67 deg. n.). Their southern limit on the European coast is near the Bay of Biscay (40 deg. n.), and on our own coast at the Winter Quarter Shoal, near the mouth of Chesapeake Bay (37 deg. n.).

About 1,500 vessels are employed in the cod-fishery of the United States.

Maine has about 540, principally from Castine, Boothbay, Portland, and Cape Porpoise.

Massachusetts has about 900 (according to the census of 1875), chiefly from Cape Ann, Cape Cod, and Boston.

Connecticut has about 60, mostly from Noank and New London.

There are also extensive boat-fisheries at Eastport (150 men), Southwest Harbor (150), Belfast (250), Castine (250), Boothbay (180), Portland (300), Cape Porpoise (80), Bristol and Matinicus (100), Cape Ann (350), Provincetown (260), Chatham (100), Hyannis (70), Nantucket (366), Edgartown (40), Nomans Land (50), New Bedford and Dartmouth (220), &c., &c. Probably 5,000 men are thus employed on the New England coast.

The most satisfactory account of the Columbia River salmon-fisheries was published in *Appleton's Journal*, May 20, 1876, by Mr. Barnet Phillips. He estimates the value of the products of the canneries at $2,500,000.

The mackerel-fishery is the fishery upon which the decision of the Halifax Commission hinged. It was claimed at the time of the session in July, 1877, that almost all the mackerel brought into the United States were taken in the waters of the Dominion of Canada, and the award was fixed accordingly at $15,000,000. It was proved conclusively before the commission that nine-tenths of the mackerel brought into our market were taken, not in the waters of Canada, but on our coast. It was really an unjust award, if it were desirable to pursue this subject fully. In regard to the distribution of the mackerel, that is another of the fishes which extend over the whole of the North Atlantic and the European coast, as well as our own. It extends farther south than the cod, but not so far north. It is found as far north as the Straits of Bellisle, and south at Cape Hatteras.

In regard to menhaden: This industry has grown almost beyond the knowledge of those who have even studied it

closely during the past four or five years. Five years ago there were four or five steamers employed; now there are sixty-six. There are some 1,500 men, and several millions of dollars employed in it. The amount of oil we obtain from the menhaden is greater than we derive from the whale. A large amount of what is called whale-oil is nothing but menhaden-oil. One house in New York offers more whale-oil than is actually brought into the United States. I am indebted to Mr. Milner for statistics in regard to the lake-fisheries.

The halibut-fishery has not been thoroughly investigated; and Lieutenant de Broca, spoken of before, has furnished us with valuable estimates.

The estimate given of the lobster-fishery is far below the truth.

As to the herring-fishery, this does not include nearly all the product of the American fisheries. It does not include the Newfoundland and Labrador herring brought by the vessels which go up there and employ the Newfoundland fishermen to catch them. These are in the Canadian reports, and to avoid duplicating them they have been included. There are probably thirty or forty trips made every year to the Magdalen Islands to bring back herring.

As to flounders: These are taken in fyke-nets in Narragansett Bay, in Connecticut, and in winter on the coast of Maine, and in summer in smacks on the shoals of Long Island Sound. * * * * * * * * * *

* * * In regard to the imperfection of the statistics furnished by the United States Census, I will only say that there is no reference whatever in the last industrial statistics to the menhaden-fishery, which we have seen amounts to almost $2,000,000 in yearly value; and if anybody who will

take any trouble to glance at the tables published by the United States heretofore, they will see that in every other particular it is as absolutely incorrect and imperfect as it can be. There was no effort made, as it appears, to cover the fisheries. As an example of the way the statistics of every kind have been jumbled together, I will state that the white-fish of the lakes and those of Long Island Sound, which are the menhaden, were all placed in one category. The herring of the sea and the herring of the lakes and the herring of the Chesapeake, which is the alewife, and the herring of the St. John, which is the menhaden, are all under one name; and so I might name a dozen instances of inaccuracies, in addition to the total inadequacy of the whole report.

I have the honor of submitting to the Association, a series of the estimated values of the Fisheries, with some details which may be of interest.

Estimates of Value of United States Fisheries, 1876.

GENERAL SUMMARY COMMISSION.

		POUNDS.
Oyster Fisheries	$50,000,000	
Cod Fisheries	4,825,540	214,322,000
Whale Fisheries	2,841,000	
Oregon Salmon Fisheries	2,500,000	30,000,000
Mackerel Fisheries	2,375,262	49,000,000
Menhaden Fisheries	1,657,790	462,000,000
Great Lake Fisheries (1872)	1,600,000	32,250,000
Shad and Alewife Fisheries (est)	1,550,000	30,000,000
Halibut Fisheries	1,546,240	22,000,000
Lobster Fisheries	1,000,000	
Herring Fisheries	507,977	28,000,000
Scup or Porgy Fisheries	504,400	7,760,000
Bluefish Fisheries	424,000	7,068,000
Swordfish Fisheries	165,000	1,500,000
Bonito Fisheries	143,000	2,200,000
Squeteague Fisheries	138,000	1,800,000
Flounder and Flat-fish Fisheries	109,620	1,827,000
Sea-Bass Fisheries	75,000	600,000
Southern Mullet Fisheries	75,000	1,000,000
Tautog Fisheries	71,000	616,000
Smelt Fisheries	50,000	400,000
Eel Fisheries	37,000	250,000
Striped Bass Fisheries	30,000	180,000
Spanish Mackerel & Pompano Fisheries	30,000	80,000
Sheepshead Fisheries	13,000	75,000
Salmon Fisheries	10,000	50,000
Other Fisheries, (est)	3,000,000	400,000,000
	$75,278,829	1,294,038,000

PRODUCTS OF MARINE FISHERIES—NORTHERN ATLANTIC STATES.

	INSHORE FISHERIES; Or Fisheries conducted from the Shore.							OFFSHORE FISHERIES; or Fisheries Conducted in large vessels, principally over 20 tons.								
	Pounds.	Price.	Wholesale Value.	Price.	Retail Value.	Price.	Mean Value.	Pounds.	Price.	Wholesale Value.	Price.	Retail Value.	Price.	Mean Value.	Aggregate of Weights.	Aggregate of Values.
Flounders and Flatfish,	1,827,000	4	*$73,080	8	*$146,160	6	$109,620								1,827,000	$109,620
Halibut, (fresh)								12,339,000	4	$493,560	15	$1,850,850	9½	$1,172,205		1,172,205
" " New York								1,000,000	10	100,000	15	150,000	12½	125,000		125,000
" (cured) Glouc'r &c.								8,476,000	2	169,520		302,500		236,010		236,010
" fins, [fitches,								2,000,000	5¼	10,500	7½	15,000	6⅜	12,750		12,750
" nopes								10,000	2½	250	3	300	2¾	275	22,025,000	275
Cod (fresh) New York	5,000,000	5	250,000	8	400,000	6½	325,000									325,000
" " Glouc'r, Bos-	*20,000,000	3	600,000	5	1,000,000	4	800,000									800,000
" cured, [ton, &c.	28,480,000					1½	379,733	160,641,700						3,319,182	214,221,700	*3,698,915
" roes	80,000	1	800	2¼	1,800	1⅝	1,300	20,000	1	200	2¼	450	1⅝	325	100,000	1,625
Tomcod	100,000	3	3,000	8	8,000	5½	5,500								100,000	5,500
Cunner	250,000	3	7,500	5	12,500	4	10,000								250,000	10,000
Tautog	615,550	8	49,244	15	92,332	11½	70,788								615,550	70,788
Mackerel (fresh)	3,481,000	8	278,480	15	522,150	11½	400,315	2,615,000	8	209,200	15	392,250	11½	300,725	6,096,000	701,040
" cured								35,632,900							35,632,900	1,674,222
Spanish Mackerel	105,000	25	26,250	30	31,500	27½	28,875								105,000	28,875
Bonito	2,000,000	5	110 000	8	176,000	6⅞	143,000								2,800,000	143,000
Pompano	5,000	60	3,000	1.00	5,000	80	4,000								5,000	4,000
Swordfish	1,500,000	7	105,000	15	225,000	11	165,000								1,500,000	165,000
Butterfish, Whiting, and	50,000	4	2,000	8	4,000	6	3,000								50,000	3,000
Sea Robins [White Perch	90,000	2	1,800	3	2,700	2½	2,250								90,000	2,250
Squeteague	1,727,600	6	103,656	10	172,760	8	138,208								1,727,600	138,208
Kingfish	10,000	15	1,500	25	2,500	20	2,000								10,000	2,000
Spot and Croaker	75,000	5	3,750	10	7,500	7½	5,625								75,000	5,625
Sheepshead	75,000	15	11,250	20	15,000	17½	13,125								75,000	13,125
Scup	7,760,000	5	388,000	8	620,800	6½	504,400								7,760,000	504,400
Sea Bass	598,500	10	59,850	15	89,775	12½	74,812½								598,500	74,812
Striped Bass	123,200	15	18,480	20	24,640	17½	21,560								123,200	21,560
Bluefish	7,068,000	4	282,720	8	565,440	6	424,080								7,068,000	424,080
Smelt	400,000	10	40,000	15	60,000	12½	50,000								400,000	50,000
Menhaden	224,834,000							478,912,500							703,746,500	†1,657,790
Eels	250,000	12	30,000	18	45,000	15	37,500								250,000	37,500
Sturgeon	75,000	5	3,750	10	7,500	7½	5,625								75,000	5,625
Sea Shad	3,770,200	5	188,510	7½	282,765	6¼	235,637½								3,770,200	235,637
Salmon	40,100														40,100	8,020
Alewife	7,385,000	½	36,925	1	73,850	¾	55,387½								7,385,000	55,387
Herring	1,604,800	2	32,096	4	64,192	3	48,144	4,000,000							5,604,800	48,144
" (cured)															22,328,700	459,833
Ratio to mile of coast line, (1.112)	31,959,950 287,392		$2,710,641		$4,658,864		$4,064,484								1,045,855,750	$13,020,821

N. B.—The Cured Cod has been restored to their green weight (three times as much).
The Salted Mackerel have been restored to their green weight (one-sixth additional).

*From Report Bureau of Statistics.
†From Official Reports.

PRODUCTS OF MARINE FISHERIES OF SOUTHERN MASSACHUSETTS AND RHODE ISLAND.

	WEIRS In Operation, on an average, four months in the year.							*LINES AND NETS.*							*Totals.*	
	Pounds.	Price.	Wholesale Value.	Price.	Retail Value.	Price.	Mean Value.	Pounds.	Price.	Wholesale Value.	Price.	Retail Value.	Price.	Mean Value.	Aggregate of Weights.	Aggregate of Mean Values.
Flounders	1,028,200	4	$41,128	8	$82,256	6	$61,692	378,000	4	15,120	8	$30,240	6	$22,680	1,406,200	$84,372
Cod								4,339,000	5	216,950	8	347,120	6½	282,035	4,339,000	282,035
Tomcod								10,000	3	300	8	800	5½	550	10,000	550
Cunner								5,000	3	150	5	250	4	200	5,000	200
Tautog	266,650	8	21,332	15	39,997	11½	30,664	39,900	8	3,192	15	5,985	11½	4,588	306,550	35,252
Mackerel	1,131,000	8	90,480	15	169,650	11½	130,065	592,000	8	47,360	15	88,800	11½	68,080	1,723,000	198,145
Spanish Mackerel	1,000	25	250	30	300	27½	275								1,000	275
Bonito	2,100,000	5	105,000	8	168,000	6½	136,500								2,100,000	136,500
Pompano	500	60	300	1.00	500	80	400								500	400
Swordfish								1,000,000	7	70,000	15	15,000	11	42,500	1,000,000	42,500
Butterfish	15,000	4	600	8	1,200	6	900								15,000	900
Sea Robins	40,000	2	800	3	1,200	2½	1,000								40,000	1,000
Squeteague	1,640,000	6	98,400	10	164,000	8	131,200								1,640,000	131,200
Scuppaug	5,858,000	5	292,900	8	468,640	6½	380,770	1,577,000	5	78,850	8	126,160	6½	102,505	7,435,000	483,275
Sea Bass	208,000	10	20,300	15	30,450	12½	25,375	221,500	10	22,150	15	33,225	12½	27,687	424,500	53,062
Striped Bass	4,000	15	600	20	800	17½	700	25,000	15	3,750	20	5,000	17½	44,375	29,000	5,075
Bluefish	835,000	4	33,400	8	66,800	6	50,100	2,451,000	4	98,040	8	196,080	6	147,060	3,286,000	197,160
Smelts								50,000	10	5,000	15	7,500	12½	6,250	50,000	6,250
Menhaden	15,110,000	½	75,550		151,100	¾	113,325								15,110,000	113,325
Eels	50,000	12	6,000	18	9,000	15	7,500								50,000	7,500
Sturgeon	25,000	5	1,250	10	2,500	7½	1,875								25,000	1,875
Sea Shad	127,000	5	6,350	7½	9,525	6¼	7,937								127,000	7,937
Alewife	4,236,000	½	21,180	1	42,360	¾	31,770	955,000	½	4,775	1	9,550	¾	7,162	5,191,000	38,932
Herring	1,604,000	2	32,080	4	64,160	3	43,120								1,604,000	48,120
Totals,	34,274,350		$847,900		$1,472,438		$1,160,168	11,643,400		$565,637		$865,710		$715,672	45,917,750	$1,875,840
Ratio to mile of Coast (250).	137,097		$3,391		$5,889		$4,642	46,573		$2,262						
Ratio to No. of men engaged in Weir-tending, (436)	78,610		$1,944		$3,377		$2,661					$3,462		$2,862	183,671	$7,504

THE SECRETARY: You heard yesterday Professor Baird speak of the necessity which existed that some data should be found or furnished by which the number of fish caught in the United States could be determined. The United States Commissioner explained to you what the advantages would have been if, in our late dispute with the Dominion of Canada in regard to the fisheries, we had had some data which might have been relied upon. You have just listened to an exceedingly valuable paper, read by Professor Goode on the same subject. It would be then of very great service to the United States if some measure could be adopted by which statistics could be furnished. We have been very fortunate at this meeting in having received the assistance of a great many gentlemen who are largely interested in fish in its most practical sense. I mean the Fishmongers' Association. I have, therefore, the honor to offer the following resolution:

Resolved, That it is very desirable, in the interests of the trade and fisheries, that an accurate knowledge should be had of the consumption of fish in New York, and that in the absence of any authoritative provision for this purpose, the Fishmongers' Association be earnestly requested to take such steps as may assist in the publication of such an annual report of fish or marine products used for food as may pass through their hands.

The resolution was carried.

General discussion of topics being now in order, Mr. GENIO C. SCOTT said: I think it would be an improvement in the trout-fisheries of this country, particularly in the neighborhood of New York, if the Canadians were invited to send us their estuary-trout. They are similar to

those of Long Island, and I have been informed that they could be furnished here for twenty-five cents a pound. I think it would stop poaching if they could be furnished as cheap as that, and I do not think it is a profitable employment to cultivate trout, though it is very amusing. We all know black-bass are profitable, and it might be worth while to cultivate striped-bass. The best way to do that is to have a law passed by the Legislature to stop the bringing of them into New York for a time. There should be a law preventing the sale of striped-bass weighing less than a pound. These are the only two things which I know of by which the fisheries could be improved. I think from the little data I have that if the estuary-trout of Canada could be brought in here, and the striped-bass could be protected, there would be great improvement.

THE PRESIDENT requested Mr. Reeder, Fish Commissioner of Pennsylvania, to give the conclusion of the experience which he told of some years ago in regard to black-bass.

MR. REEDER: I presume that you refer more particularly to the experience which I had in regard to the growth of bass. I am fully satisfied, so that I can say without hesitation, that black-bass spawn where food is abundant in early summer or late spring. At that time the next year they will weigh three-quarters of a pound to a pound, and be mature fish. I have been so often called upon before the Association to give my experience in regard to bass, that I do not feel as if I could say anything which would be entertaining or interesting; but there is one subject on which I think I can state some new facts. In 1871, before any commission was appointed by the State of Pennsylvania, Mr. Norris and myself purchased some salmon-eggs from Mr.

Wilmot. They were put in charge of Mr. Chrystie, who had a hatching-house in this state, near Poughkeepsie. After hatching the fish and bringing them on for the purpose of introducing the young into the river, they met with such an unfortunate detention in the city of New York that very few were put in alive. We repeated the experiment in 1872, when we succeeded in hatching about 10,000 of the *salmo salar*, and we introduced these into a tributary of the Delaware River. In 1873, Professor Baird put into our charge, I think, some 40,000 eggs, of which we hatched 27,000 young, and introduced these into another tributary of the Delaware River. The Fish Commission of Pennsylvania was formed that year, and I became a member. My connection with the introduction of salmon has been unofficial. After the introduction of the *salmo salar* in 1873, we introduced them in 1874. We then thought it unwise to experiment further, thinking it would be a failure. We abandoned that idea, and have been introducing the *salmo quinnet*, or California salmon, ever since. This year, however, there have been nine mature salmon caught in the Delaware River. One of them was quite a large fish, but had a very weak back, in consequence of the length of time it had been out of salt-water. I judged from the size of that salmon that when it was a fresh-run fish it would have weighed sixteen pounds. When caught it weighed ten and a half pounds, and was ready to deposit its spawn. After examining the fish, I was forced to come to the conclusion that the fish was not a California salmon, but a *salmo salar*. In order to have my judgment confirmed, I sent the fish to Professor Gill, of the Smithsonian Institute, and he pronounced it a *salmo salar*. This was the only fish that we subjected to a scientific examination. The other fish were

caught by the fishermen during the shad-fishing season in nets. One was caught in a shad-net below Philadelphia. Prior to that time a fisherman had caught a salmon weighing eleven pounds. As he saw it before it escaped, he said he thought that salmon was so much larger than the one that weighed eleven pounds that he thought it would have weighed at least twenty-five pounds. As we introduced no fish into the Bushkill until 1873, I am of the opinion that these fish were five-year-old salmon, and the product of the eggs hatched in 1872, and I have no doubt that the product of 1873, returning next year, will give us many more salmon in the Delaware River next year than this year, and I hope to have, among others, the pleasure of forwarding to Professor Baird the first California salmon. This is but a very small return, it is true, for the number of eggs introduced into the Delaware, but to my mind it is a solution of the problem. I know that one swallow does not make a summer, but where we see one swallow we can infer that more are coming. We know this, that the salmon that are introduced and have been introduced into the Delaware and its tributaries have been there as young fish, and returned there from the sea; that they came back full of ripe spawn ready to deposit and reproduce; and if that is not a solution of the question that salmon can be introduced as far south as the Delaware, I do not think that any theory can be discovered from a statement of facts.

MR. HALLOCK: The object of my getting up was to say that in view of the suggestions of Mr. Scott, and of the concurrence of all of us with his ideas of the desirability of introducing the estuary-fish, and estimating the growth of all fish, I wish to say that there has been started with-

in a week a large club of influential men, whose province it will be to take charge of the fishing interests of Harlem River, the Westchester creeks, and all the little tributaries around the city, and they hope that, by the coöperation of ourselves and other gentlemen here and elsewhere, that they will be able to make a better showing in a short time than at present.

MR. SCOTT: Bass-fishing this last fall has been better around New York than for thirty years. So all the boatmen say. I went down late in the season, and I found most beautiful bass. I took from fifteen down to five fish, and never found so good fishing before; and that reminded me, as we supposed that by the fishery of the menhaden we were depleting the water of the ocean, but instead of that, menhaden have been more numerous than ever. How can you account for that? Perhaps some gentleman will state why bass, after the streams have been fished and netted and hacked for so many years—why we found bass more numerous than ever.

THE PRESIDENT: I would like you to seek an explanation why the price of bass has risen from twelve to twenty cents a pound, as it is now.

MR. SCOTT: I am led to conclude that bass for the market are taken in bays, and have decreased. I was speaking in regard to what were immediately about New York—fishes taken with the rod and reel. I suppose Mr. Blackford could tell how the waters of the East are depleted, and that they are obliged to charge more for bass, because they supply a great share of them. One thing, moreover, we know, in connection with bass-fishing near New York, that on the south side of Long Island the fishing was better last fall than

at Basque Island and Cutty Hunk. I was speaking of the fish that come in from the sea and we take in the Kill von Kull and the outlet of Newark Bay.

THE PRESIDENT asked Mr. Haley and Mr. Lamphier to tell about the number of bass in the market, &c.

MR. DUDLEY HALEY: It is a fact that there are not as many bass through the market as there were twenty years ago. Then we used to catch as many bass as we wanted. Now there are very few. The same thing occurs with cod-fishing. Some seasons there are no sea-bass, other seasons any quantity of them. I am sure that I cannot explain why it is.

THE PRESIDENT: Has there been a gradual diminution of the supply of bass?

MR. HALEY: No, sir. Some seasons they are scarcer than others.

THE PRESIDENT: How do you account for the rise in price?

MR. HALEY: Scarcity and more demand than there was twenty years age. I do not know but that they are more popular. I think so.

MR. BLACKFORD offered the following resolution, which was agreed to:

Resolved, That the thanks of this Association are due to Professors Milner and Goode for their exceedingly interesting papers on subjects of the highest importance to the Association, and that in affording the opportunity of acquiring information, these gentlemen are fulfilling not only roles of useful members of the A. F. C. A., but of public instructors.

MR. ANNING asked for information in regard to putting the eggs of trout in soft or hard water, and said that in

his experience that eggs put in soft-water will not stand as much as those placed in hard water.

MR. GREEN: My opinion on the subject is from one of our men who has charge of the hatching in Greene county. He took a great many eggs in that county last fall, and took a great many from our state. The eggs from Greene county were all from soft-water. The water the spawn was taken from was soft-water. His experience showed that the eggs taken from the fish in the soft-water were very much thinner than those taken from the hard-water—that is, from the lime-water, and I am of the opinion that they will not bear transportation as well. The soft-water fish will not bear the transportation that the hard-water fish will. When you come to ship the eggs, the advantage would be very much in favor of the hard-water trout. By hard-water, I mean any water impregnated with lime.

MR. PAGE described an establishment for hatching the *salmo fontinalis* at Rangely Lake, Maine. Trout had been taken with the fly during the spawning-season; also, that a large number of the blue-black trout and their eggs had been distributed through Maine. The fact is of great interest, as it is the first establishment of a permanent hatching-house for the purpose of propagating that species of the *salmo fontinalis*, or of that variety which, I believe, is now admitted to be the largest known in the world. The nine-and-a-half-pound trout from the Rangely Lake was sent to the Smithsonian Institute. If it reached Professor Baird, I think it will be on record as the second largest trout known. The largest was that of ten pounds, taken in 1867 in the same water.

MR. MATHER: Mr. Page stated that the trout had been

taken with the fly during the spawning-season. I would say that I have taken the grayling with the fly, and taken the spawn from the fish immediately after, and also that there is to be an effort this spring to take grayling spawn.

MR. BLACKFORD suggested certain changes in the organization of the sections whose duty it was to report on special subjects.

The following gentlemen were appointed for 1878–'79:

SECTION 1.	Mr. S. Green, Mr. S. Wilmot.	*Methods in Fish-Culture, etc.*
SECTION 2.	Mr. C. B. Evarts, Mr. L. Stone, Mr. T. B. Ferguson,	*Fishery Laws and Fish-Ways.*
SECTION 3.	Mr. J. W. Milner, Mr. F. Mather, Mr. C. H. Hallock,	*Natural History, etc.*
SECTION 4.	Mr. E. G. Blackford, Mr. B. Phillips,	*Fisheries.*

MR. MILNER offered the following resolution:

Resolved, That this Association tender their thanks to the officers and members of the Fulton Market Fishmongers' Association for the use of their rooms. At the same time the American Fish Cultural Association are desirous of expressing the pleasure they feel at having had associated with them so many gentlemen directly representing, in a commercial sense, the fishing interests of New York, and that they are quite sanguine in the belief that the impression of such a practical working element must advance the interests of the Association.

THE PRESIDENT: I would like to say a word or two to

express even more fully than the resolution does our appreciation of the great benefit that can be obtained in the labors which we have at heart by the coöperation of the gentlemen in this city interested directly or indirectly in the fish-business. We can obtain from their experience a very large mass of information that will be exceedingly valuable. All sides hunger after statistics. Upon satisfactory statistics we must depend for any conclusions to which we may arrive. As you have heard here, one gentleman arrives at one conclusion from his experience, and another at another from his experience. You will find a difference of opinion on points on which you would suppose there would be no difference, and it is only by obtaining a mass of facts, a large number of results, that we can finally attain some absolute conclusions. Now these gentlemen, dealing as they are largely in fish, can give us their conclusions on a much larger scale even than we can reach, and they, too, form a test of our knowledge that puts us to the requisite care in forming conclusions, and makes us careful in our statements. I knew to-day, when I had to read before you the statement that nobody had ever found mature spawn in eels, I was making a statement in the face of all of those gentlemen through whose hands pass millions of eels every day. At the instant some one might get up and say, "You are mistaken. We find eels with mature spawn exactly the same as other fish;" and it was with entire satisfaction that I received the assurance from Professor Baird that we had under a microscope discovered spawn of eels in a mature condition. We can also, with the coöperation of these gentlemen, obtain proper legislation. The object of this Association is principally to increase the business and supply of fish. I think we will meet with the hearty coöperation of those

gentlemen, of the Fulton Market as our purposes are the same. For instance, I might speak of what Mr. Scott has alluded to in regard to bass, and might add something in regard to the selling of immature blue-fish. Now should the wholesale market fail to receive them with the other fish sent here, they would know that in selling those little blue-fish they are destroying their own business, recognizing as we do that in destroying these half-grown little fish, they destroy their own supply. In this and many other points the Fulton Market Fishmongers' Association can be of great service to us; and it has been of great satisfaction to us, and I know to all members of the Association, that they have tendered to us the use of their rooms, invited us to meet here, and shown a disposition to unite with us in our action. In alluding yesterday to a feeling of jealousy, I did not allude to these gentlemen, but to the gentlemen who were taking the fish, and who were at first a little jealous. There is no reason for jealousy between the fishmongers and ourselves, and I am sure that the resolution just offered will meet the hearty approval of every member of the Association.

Resolution put and carried.

The Treasurer read a list of new members who had been proposed.

On motion, the meeting adjourned, to assemble again in February, 1879.

[In changing the name of the Association from Fish Culturists to Fish Cultural, the Secretary proposed that in the Constitution, after the final word Fish Culturists, the following be added: "*and the treatment of all questions regarding fish, of a scientific and economic character.*" This change and addition to the Constitution was adopted.]

NEW YORK, FEBRUARY, 1878.

AMERICAN FISH CULTURAL ASSOCIATION, in Acc't with EUGENE G. BLACKFORD, **Dr.**

1877.			
February 19,	To Cash paid for use of Chairs at Meeting	$ 7 50	
" 28,	" " J. M. Davis for Printing	10 25	
March 6,	" " Reporter of Aquarium Meeting	70 50	
" 21,	" " " " Centennial "	30 00	
" 26,	" " for Expressage on Package from Mr. Edmunds	1 00	
" 29,	" " Estate of J. Reay for Printing	7 50	
April 9,	" " Mr. Edmunds for bill Sundries	14 45	
" "	" " for Telegram and Messenger	75	
1878.			
February 5,	" " J. M. Davis on account of his bill of Printing	125 00	
" 27,	" " Postage on Reports mailed	3 19	
" "	" " Signs for meeting this day	1 75	
		$271 89	

Per CONTRA, **Cr.**

By Balance on hand as per last Report	$76.39	
Amt. received for Fees from Members last annual meeting	72.00	$148 39
Balance due E. G. Blackford		$123 50

CONSTITUTION.

ARTICLE I.—NAME AND OBJECTS.

The name of this Society shall be "The American Fish Cultural Association." Its objects shall be to promote the cause of Fish Culture; to gather and diffuse information bearing upon its practical success; the interchange of friendly feeling and intercourse among the members of the Association; the uniting and encouraging of the individual interests of Fish Culturists, and the treatment of all questions regarding fish, of a scientific and economic character.

ARTICLE II.—MEMBERS.

Any person shall, upon a two-thirds vote of the Society, and a payment of three dollars, be considered a member of the Association, after signing the Constitution. The annual dues shall be $3.00.

ARTICLE III.—OFFICERS.

The officers of the Association shall be a President, a Vice-President, a Secretary, a Treasurer and Executive Committee of seven members, and shall be elected annually by a majority of votes; vacancies occurring during the year may be filled by the President.

ARTICLE IV.—MEETINGS.

The regular meetings of the Association shall be held once a year, the time and place being decided upon at the previous meeting.

ARTICLE V.—CHANGING THE CONSTITUTION.

The Constitution of the Society may be amended, altered, or repealed, by a two-thirds vote of the members present at any regular meeting.

MEMBERS

OF THE

American Fish Cultural Association.

Ambler, Andrew S., Danbury, Conn.
Anderson, A. A., Bloomsbury, N. J.
Annin, James, Jr., Caledonia, N. Y.
Baird, Spencer F., U. S. Commissioner of Fish and Fisheries, Washington, D. C.
Benjamin, Pulaski, New York.
Benkard, James, New York.
Betteman, C. G., Greenville, N. J.
Blackford, E. G., New York City.
Boardman, H. G.
Boyer, B. Frank, Reading, Pa.
Bradley, Richards, Brattleboro, Vt.
Brewer, J. D., Muncey, Pa.
Bridgman, J. D., Bellows Falls, Vt.
Burges, Arnold, West Meriden, Conn.
Bush, John T., Niagara Falls, Canada.
Campbell, Anthony, Brooklyn, N. Y.
Carman, G., New York.
Comstock, Oscar, New York.
Chandler, F. J., Alstead, N. H.
Chappel, George, New York.
Chrysley, Gifford W., Kinderhook, N. Y.
Clapham, Thomas, Roslyn, L. I.
Clift, William, Mystic Bridge, Conn.
Colburn, Charles S., Pittsfield, Vt.
Collins, A. S., Caledonia, N. Y.

Coup, W. C., New York City.
Crocker, A. B., Norway, Maine.
Edmunds, M. C., Weston, Vt.
Evarts, Charles B., Windsor, Vt.
Farnham, C. H., Milton, N. Y.
Farrar, Benjamin, St. Louis, Mo.
Ferguson, T. B., Baltimore, Md.
Gill, Theodore, Washington, D. C.
Goode, J. Browne, Washington, D. C.
Green, Seth, Rochester, N. Y.
Hallock, Charles, New York City.
Haley, Albert, New York.
Haley, Caleb, New York.
Harris, J. N.. New York.
Hessel, Rudolph, Offenburg, Germany.
Hewett, C. L. Holidaysburg, Pa.
Heywood, Levi, Gardner, Mass.
Holley, W. P., Katonah, N. Y.
Hooper, H. H. Charleston, N. H.
Hunt, J. Daggett, Summit, N. J.
Hunt, N. W., 70 Lee Avenue, Williamsburg, L. I.
Hunt, Luther B.
Huntington, Dr., Watertown, N. Y.
Hutchinson, Chas., Utica, N. Y.
Jerome, George H., Niles, Mich.
Jewett, George, Fitchburg, Mass.
Kent, Alexander, Baltimore, Md.
Kingsbury, Dr. C. A., 1119 Walnut St., Philadelphia.
Lamberton, Alexander B., Rochester, N. Y.
Lamphear, George, New York.
Ledyard, L. W., Cazenovia, N. Y.
Lees, Edward M., Westport, Conn.
Lowrey, G. P., Tarrytown, N. Y.
Lyman, Theodore, Brookline, Mass.
Maginnis, Arthur, Stanhope, Pa.
Malcomson, A. Bell, Jr., New York City.
Mann, J. F., Lewiston, Pa.

Mather, Fred., Newark, N. J.
Middleton, W., New York.
Miller, S. B. New York.
Miller, Ernest, New York.
Milner, James W., Washington, D. C.
Mull, B. E., New York.
McGovern, H. D., Brooklyn, N. Y.
Neidlinger, Phil., New York City.
Newell, W. H., San Francisco, Cal.
Page, George S., New York City.
Parker, Wilbur F., Meriden, Conn.
Paxton, E. B., Detroit, Mich.
Phillips, B., Brooklyn, N. Y.
Porter, P. B., Colorado.
Price, Rodman M., N. J.
Redding, B. B., San Francisco, Cal.
Redding, George H., Stamford, Conn.
Reeder, H. J., Easton, Pa.
Richmond, W. H., Scranton, Pa.
Rogers, A. L., New York.
Rogers, H. M., New York.
Robinson, R. E.
Rockford, A. P., Salt Lake City, Utah.
Roosevelt, Hon. Robert B., New York.
Saltus, Nicholas, New York City.
Shultz, Theodore, New York City.
Smith, Greene, Pelerboro, Va.
Sprout, A. B., Muncey, Pa.
Stetson, J. A., Gloucester, Mass.
Sterling, E. Cleveland, Ohio.
Stone, Livingston, Charleston, N. H.
Stoughton, E. W., Windsor, Vt.
Tagg, Henry, Philadelphia, Pa.
Thomas, H. H., Randolph, N. Y.
Tileston, W. M., New York City.
Van Cleve, Joseph, Newark, N. J.
Van Wyck, J. T., New York City.

Ward, George E., New York City.
West, Benjamin, New York City.
Whitcher, W. F., Ottawa, Ontario, Canada.
Whitcomb, T., Springfield, Vt.
Whitin, Edward, Whitinsville, Mass.
Wilmot, Samuel, Newcastle, Ontario, Canada.
Willets, J. C., Skeaneatles, N. Y.
Woods, Israel, New York.
Worrall, James, Harrisburgh, Pa.
Yarrow, Dr. H. C., U.S.A., Washington, D. C.